POWER

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The Coal Strike

THE coal strike is over, or will evidently be by the time this gets to the reader.

The orderly life of a large section of the community has been upset. Families with idle bread winners have suffered, dependent industries have been crippled and trade in the affected districts paralyzed. The ultimate consumer has been "stuck up" as usual, and ghouls have fattened on his predicament.

The impotency of a government dependent for its powers upon the delegated authority of conflicting interests has been mortifyingly demonstrated.

When the victimized people ask, "What can we, in our organized, collective capacity, through those whom we have chosen to act for us, do in an orderly, lawful way as good citizens should, to meet this kind of imposition?" they are told to "Sit quiet and not rock the boat!"

The condition has started some mental tackle to working and driven in some stakes of conviction to which that tackle can be hitched, as awakened protest tugs to overcome intrenched privilege and unorganized inertia.

And one of these convictions, growing stronger the more thought it gets, winning new advocates every day, becoming more obvious with each such demonstration as that through which we have passed, is that

The mining and distribution of coal is charged with public interest and subject to public control.

It does not matter who owns the coal. The mining and distributing and selling of it are public services. When the public knows how much that service costs, it can intelligently tell the owners and operators and distributors how much they may make out of it, and the miners what proportion of it their wages shall be.

F. R. Low

Modeling as an Aid in Power-Plant Piping Design

By C. T. VAN DUSEN*

CONDUCTED as a part of, and simultaneously with, the drafting-room work, modeling proves to be of great value in the design of power-plant piping.

IN LARGE power plants the piping is becoming more elaborate and more complicated as new refinements of design are adopted. There are a greater number of distinct systems of piping, and the size and extent of nearly all systems has been increased. Recently, it has become evident that drafting-room methods were not keeping pace with this trend of development.

It is the relation of the various systems to one another and to the other elements of the plant that is difficult. Points of design such as physical strength, flexibility and diagrammatic arrangement are relatively simple, but matters such as ready access to valves, proper clearances for maintenance work and a neat and orderly appearance of the piping as a whole are taken care of less satisfactorily by ordinary drafting-room methods, because it is difficult to show them on drawings.

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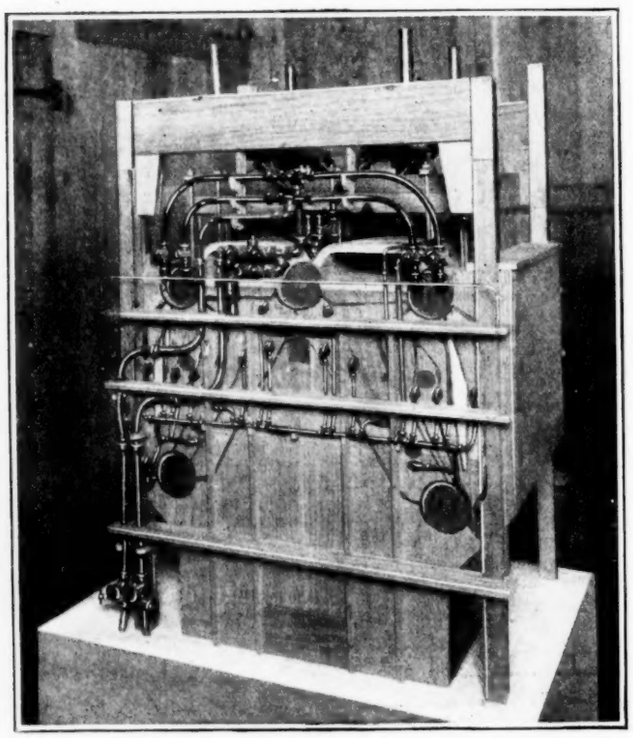


Fig. 1—Model of 41,500-sq.ft. boiler for heating plant

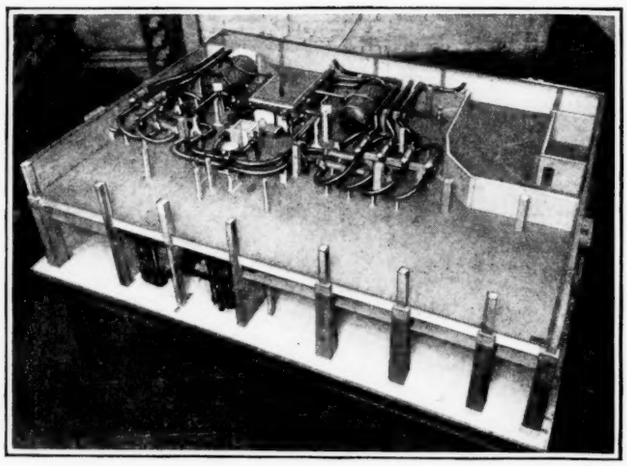


Fig. 2—Model of a preliminary design showing principally main steam piping and water treatment system

The matter of appearance has been given altogether too little attention in piping design. A group of valves and fittings can be so arranged that the scheme of the design and the function of each valve can be instantly recognized by the operator, whereas, if they are put together in a careless fashion with perhaps an eye merely to the use of a minimum number of fittings, the result will be much less desirable from an operating viewpoint. Nor should good appearance for its own sake be neglected. A neat and symmetrical arrangement of piping is surely as important as any other element that affects the appearance of the plant, and is certainly desirable in the maintenance and operation of it.

In accomplishing these things the chief difficulty is the inability of the designer to visualize the appearance of a multiplicity of pipe lines and their relation to one another. To facilitate the work the Detroit Edison Company decided to undertake modeling on an extensive scale and carry it along simultaneously with the design. In the beginning this work was in the nature of an experiment to determine whether or not models could be made and assembled as rapidly as the design work progressed, this being a fundamental requirement if the model was to have any value as an accessory to the drafting-room work. Past experience with the building of models of power plants, particularly of interior representations, where piping is to be shown, gave rise to not a little scepticism on the practicability of rapidly producing models to keep pace with the design and drafting progress.

Consider for a moment a model of a complicated group of piping such as is shown in Fig. 1. It is obvious that to fabricate this model of wood and assemble it would require a considerable amount of patternmakers' time. How else can this model be made except to turn up a large number of separate pieces on a lathe and afterward cut and fit them together, which is a slow and fussy job? Then suppose that in this model, representing a preliminary design, the engineers wish to see some extensive revisions made; it is then an equally difficult task to change the model, if made of wood, and make a neat job of it. Permanence in these wood pipe models is not warranted for reasons of possible changes and a short period of usefulness,

nor by the same token can be justified the careful joinery necessary to produce a presentable model in wood.

For these reasons and the difficulty of rapidly producing and thereafter rapidly making changes required, an attempt was made to find some substance that might be better adapted to pipe modeling. Pure beeswax was tried and after some experimenting proved unsatisfactory, as it was too plastic and too easily affected by high summer temperature to be practical for the purpose. Further experiments with a mixture of another more brittle wax with beeswax, gave a product that was pliable enough for making bends when warmed and yet stiff enough when cool so that it could be shaped by wood-working tools, and would keep its shape under any summer temperature likely to occur.

The wax method of representing pipes is briefly this: Having, with the necessary apparatus, produced round wax sticks of various diameters to the scale of the model and lengths of proper rectangular sections, the round stick may represent a pipe and the much smaller rectangular stick, when bent around the round stick, may represent a flanged joint wherever one occurs between fittings, valves, etc. Where bends are required, the stock may be warmed slightly and bent, setting permanently in this shape as it cools. In the case of short-radius ells, tees or other connections, the wax sticks may be mitered and stuck together with hot tools and the joint reinforced, if necessary, by long wire nails. Where it is easier to use a wood turning instead of wax this is done.

As to the production of these wax stocks which really make this wax method possible, an apparatus was devised for extruding the special wax compound through dies of any cross-section, rectangular or round. The simple mechanism used thus far may be described as consisting of a pressure cylinder with a die holder on one end and a plunger, operated by a hand screw, in the other end. Both the cylinder and die holder are jacketed with hot water to reduce the skin friction in the cylinder and to keep the die warm. The dies are best described as various sizes of sharp-edged orifices in brass plates, the plates being all of the same size so as to be interchangeable in the holder.

For extruding wax sticks of small diameter, a soft copper wire core is used to reinforce the limber pipes. This core keeps them from sagging on warm days. The wire core has an added advantage in making joints. A special die head is required for this extruding.

The first large job that was undertaken by this method was for a central heating plant, to be equipped ultimately with 12 boilers aggregating 498,000 sq.ft. of heating surface, where, with the first installation of two 41,500-sq.ft. boilers, a thorough study was made of the ultimate piping layout to get the best arrangement of the various piping systems, from the viewpoints of appearance and facility of operation and maintenance. This model was built to the scale of $\frac{1}{2}$ in. = 1 ft. and by floors, in layers so to speak, as illustrated in Fig. 3.

The sections are cut just under the framing on each floor and consist of the floor and three walls, one side being left out so that the interior may be viewed when the model is assembled. Each section is hinged at the back with loose-pin butts, so that the entire assembled model opens like a fan to facilitate inspection and study and for the further reason that any floor may be entirely removed to be worked upon. This tends to speed up the work, as all four sections can be worked upon simultaneously by different patternmakers.

A model shop was set up near the engineering and design headquarters, so that those interested or engaged in the design work had ready access to the models as the work progressed. This shop is equipped as a pattern shop would be, with all necessary wood-working machinery and in addition the wax apparatus. It was found necessary to employ three patternmakers and a helper at the busiest period in order to produce the various piping set-ups in the required time.

In concluding, it is interesting to note that in the piping design of this heating plant a great many of the important decisions reached by the engineers regarding both general and detail arrangement were made by discussing the model rather than the drawings. It is felt

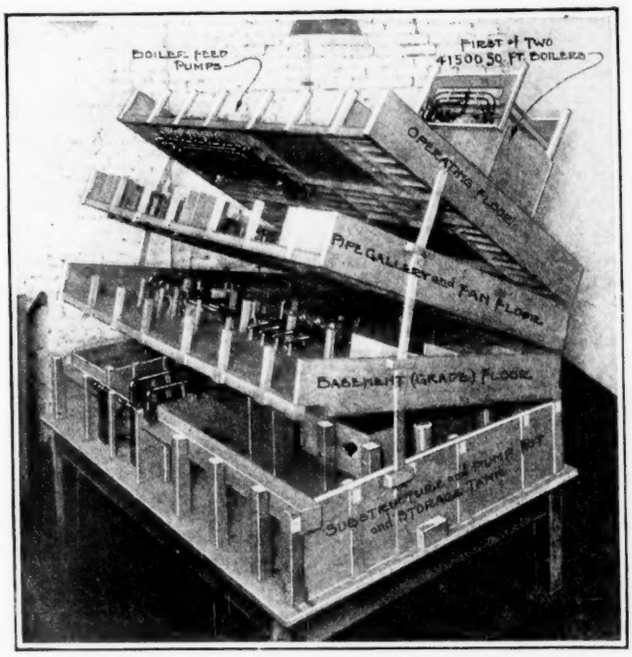


Fig. 3—Assembled model of plant opened for inspection

that the expense of the model work is many times paid for in eliminating costly field changes and unsatisfactory features in the first designs. For what is had in the model is the actual plant in miniature, and those whose duty it will be to operate and maintain the plant after it is built, can view it beforehand and make their criticisms and suggestions while the design may yet be altered.

To get the fullest value out of the modeling, the shop facilities should be available for rapid work and the apparatus for producing wax, or first the matter of procuring the wax stock of the proper durable compound should be attended to. The model itself should be started as soon as the preliminary plans are completed for the building. The shell of the model will then be ready by the time decisions are being made regarding various pieces of equipment, models of which afterward may be made and properly placed and the piping fabricated and installed as fast as the preliminary design drawings are produced.

It should be mentioned that in order to represent a group of high-pressure steam piping properly as it will appear in the finished plant, it should be shown as covered pipe, as the thickness of covering makes quite a difference in the diameter of the model stock.

Checking the Polarity of Interpoles

By C. O. Mills

ON AN interpole motor the interpoles are in all cases the same polarity as the neutral zone on the armature under the polepiece. This relation is shown in Fig. 1. The reason for this is that the interpoles are intended to neutralize the armature's field and also provide a flux to assist in commutation. If the interpole field is made of the proper strength, sparkless commutation should result. The figure also shows the relation between the interpole polarity and that of the main poles for the direction of rotation indicated by the curved arrow on the armature. From the figure it is seen that an interpole is the same polarity as the trailing main pole.

Correct Polarity Essential

It is necessary that the interpoles have the correct polarity if the machine is to operate satisfactorily. When the interpole coils are assembled on the polepieces, they should be tested for correct polarity before the armature is put in place. This can be done by connecting a water rheostat in series with the coils and to the line as indicated in Fig. 2. If an ammeter

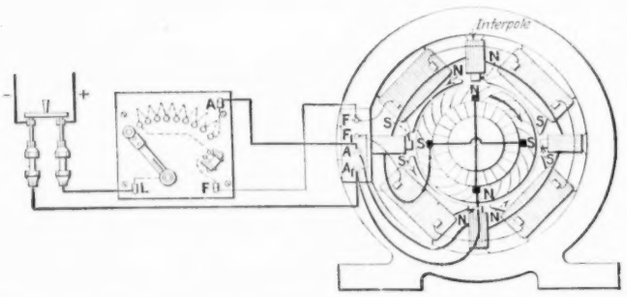


Fig. 1—Diagram of a shunt-interpole motor connected to a manual-type starting box

is available, it should be connected in series with the coils to indicate when the current is of a suitable value. Where an ammeter is not at hand, the judgment of the one making the test must be relied upon. Some idea can be gained by the amount of bubbles around the movable electrode in the rheostat. The amount of current flowing will depend upon the amount of salt in the solution and the distance between the electrodes.

To be sure that the current will not reach an excessive value, a piece of 10-ampere fuse wire may be put into the circuit, and when the current reaches a value where this blows, it will be known that the position of the electrodes is such that about 20 amperes are flowing in the circuit. After the current has been adjusted and the polarity of the interpoles tested, it will be a good idea to reverse the current through the coils and test again. This time the polarity should show the reverse of what it was on the previous test.

After the polarity of the interpoles has been found correct, the machine may be assembled and started and the correct rotation established. To check the relation between the polarity of the interpoles and the main poles, open the shunt-field circuit at the starting box, shift the brushes in the direction of rotation, as indicated in Fig. 3, and try starting the motor again. If the polarity of the interpoles is correct, the armature will revolve as when the shunt field was connected into circuit.

No attempt should be made to cut out the starting resistance with the interpoles in use only, or the machine will spark badly at the brushes and reach a dangerous speed. Before shifting the brushes, their position should be carefully marked, so that they can be returned exactly to this position again. The brushes

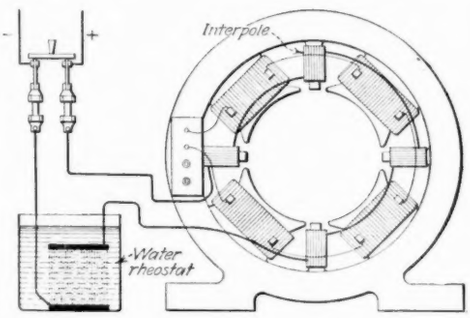


Fig. 2—Interpole windings connected to a water rheostat to test polarity of polepieces

or interpole machines are sensitive to position, and unless they are correctly located trouble from sparking is likely to result. In making the test indicated in Fig. 3 on a compound machine, it will be necessary to cut out the series-field winding as well as open the shunt-field winding.

Position of Brushes

As already mentioned, the brushes on an interpole machine should be in the correct position. On a generator, shifting the brushes ahead of the neutral, the effect will be similar to that where the series winding opposes the shunt winding; that is, the voltage will be decreased with the load. Moving the brushes back of the neutral will tend to make the voltage rise on the machine. On a motor the speed will increase if the brushes are shifted back of the neutral and decrease if they are shifted ahead. If the interpoles are too

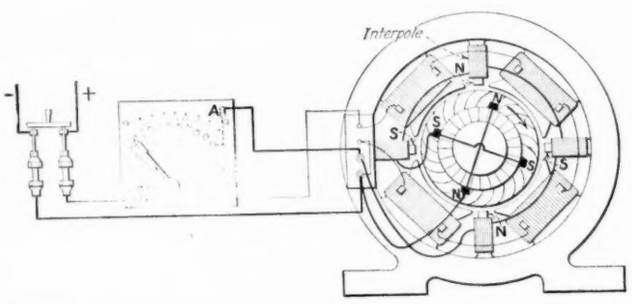


Fig. 3—Same as Fig. 1, except the brushes are shifted ahead of the neutral to test polarity of the interpoles

strong, the motor is likely to be unstable in its operation and may even race. Interpoles that have sufficient strength will tend to cause the motor to slow down and spark at the brushes. With all the other effects previously mentioned, serious sparking at the brushes is also likely to occur.

Centrifugal Compressors for Diesel Engines*

Increasing Power by Supercharging—Use of Centrifugal Blowers for Scavenging —Exhaust-Gas Turbine Increases Engine Efficiency

By SANFORD A. MOSS†

ONE development toward obtaining more power per unit cylinder volume to the Diesel engine, which is proceeding quite rapidly, is the use of high-speed centrifugal compressors for scavenging and supercharging both two- and four-stroke-cycle engines.

The centrifugal compressor consists of an impeller carrying properly shaped blades, which rotates at high speed in a casing with suitable inlet and discharge conduits. Such compressors are now in extensive commercial use, both in this country and abroad, for supplying air for various purposes. Types that supply air at pressures of from 1 to 5 lb. per sq.in. are being used commercially with Diesel engines.

Scavenging of two-stroke-cycle engines is accomplished in four ways. In one method the air is compressed in the crankcase by means of the lower side of the piston, but more recently there has been used a separate piston and cylinder operating in synchronism with the main piston.

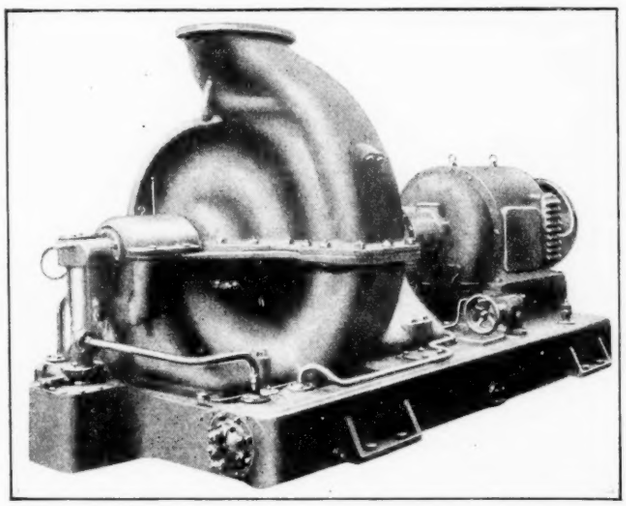


Fig. 1—Motor-driven blower used with a four-stroke-cycle marine engine

The receiver method uses a reciprocating blower and a large receiver within which is an approximation to constant pressure. Claims have been made that a reciprocating blower with timing gives better performance than the constant pressure of a receiver, but it is nevertheless true that many engines with constant-pressure scavenging are as successful as those with timing.

The centrifugal compressor gives a constant scavenging pressure. Tests show that the pressure actually needed for given results is lower than the average value of the irregular pressure of the receiver method.

Supercharging of four-stroke-cycle engines is desirable because without it the charge of air at the beginning of the compression stroke has a low density, due to a lower pressure and a higher temperature than that of the atmosphere. Supercharging gives an increase in the amount of charge, and hence in the amount of power delivered, by supplying the intake manifold with air at a pressure appreciably above atmospheric.

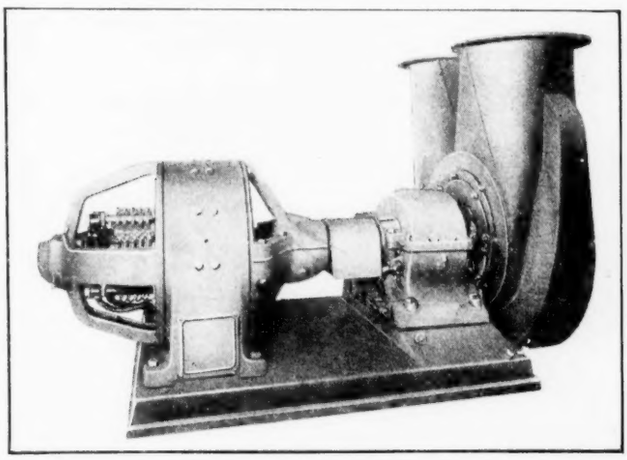


Fig. 2—Scavenging blower used in one of Ford's motorships

By increasing the pressure of the scavenger of a two-stroke-cycle engine, any desired amount of supercharging may also be obtained, provided the air ports remain open after the exhaust ports have closed or that the engine exhausts against a back pressure.

The most outstanding application of a two-stroke-cycle engine with a centrifugal scavenger is on the "Aorangi," a quadruple-screw liner of 23,000 tons displacement. Four 6-cylinder, two-stroke-cycle Sulzer engines developing a total of 13,000 shaft hp. at 127 r.p.m. give the greatest power so far used in a Diesel ship. The scavenging and supercharging air is supplied by two centrifugal blowers, each capable of delivering 34,000 cu.ft. of air per minute against a pressure of 1.75 to 2.1 lb. per sq.-in., while a third unit acts as a stand-by. Besides the usual scavenging ports uncovered by the stroke of the piston, there is a row of automatic multiple-disk valves just above them, which open when the exhaust pressure falls below that of the scavenging air and which remain open after the exhaust valves have been closed on the return stroke, until the air pressure in the cylinder equals that of the scavenging air. This provides for greater than atmos

*Extract of a paper read at Winter Meeting, American Society of Mechanical Engineers, New York City, Dec. 1, 1925.

†Engineer, General Electric Co.

pheric pressure in the cylinder at the beginning of compression, or true supercharging.

Another application in an entirely different field is that of the new Baldwin locomotive, whose driving element is a Knudsen Diesel engine, using a blower for scavenging.

The greatest use of centrifugal compressors for supercharging four-stroke-cycle engines has been in Germany, and they are now used there on practically all new projects.

The supercharged four-stroke-cycle Diesel engine which has been in operation for the longest time is that of the Norwegian ship "Tiradentes." When the ship was first operated, it did not develop sufficient speed, and a centrifugal supercharger was added which increased the indicated horsepower from 3,100 to 3,600 and the speed of the ship from 10½ to 11½ knots.

With the supercharger in operation the exhaust temperature varies from 806 deg. to 842 deg., which is higher than with ordinary four-stroke-cycle engines. The exhaust is entirely invisible and there are no soot deposits in the exhaust conduit. Every 40 days the exhaust valves have to be reground instead of every 60 days as would ordinarily be the case, and a somewhat increased amount of cooling water is required. These points are a small price to pay for the increased power.

When a centrifugal compressor is operated in the neighborhood of its rated load, if the compressor speed is varied the pressure rise varies approximately as the square of the speed. The rated volume of a compressor varies directly as the speed, hence if the speed of a given compressor is doubled, the volume to which it is suited is also doubled and the pressure rise that it produces at the double volume is quadrupled. A centrifugal compressor geared to an engine is therefore automatically maintained at its rated volume, since as its speed is increased the volume demanded by the engine is increased in the same ratio. Friction losses through valves and ports vary directly with the square of the volume; hence, as already stated, a geared compressor automatically gives a pressure rise that overcomes friction losses at all speeds and, if there is supercharging, gives supercharging pressure varying with the square of the speed.

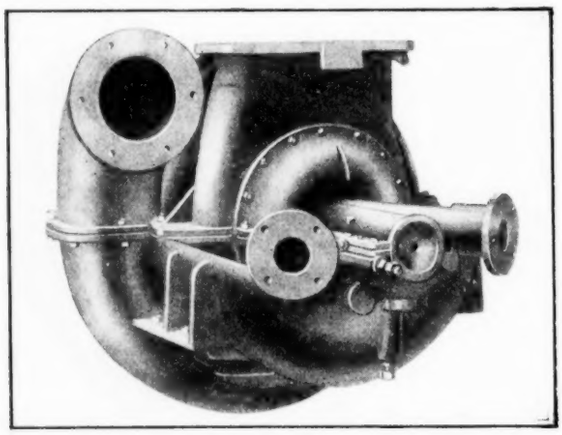


Fig. 3—Brown-Boveri exhaust-gas turbo-blower

The most important advantage of scavenging a two-stroke-cycle engine by a separate centrifugal compressor is the great reduction of cost and weight. When a Diesel engine is designed for a separate air supply, besides dispensing with the huge blowing cylinder with all its accessory valves, rods, etc., the massive base can be made considerably shorter and more than proportionately lighter.

Improvement in low-speed operation has been obtained with centrifugal scavengers due to increased supply of scavenging air. This is due to the use of full pressure with decreased air friction resulting from the low speed.

No data are available as to the actual efficiency of reciprocating scavengers, but efficiencies greater than 75 per cent are guaranteed for centrifugal compressors. The efficiency of a reciprocating blower is probably lower, on account of volumetric efficiency and friction losses.

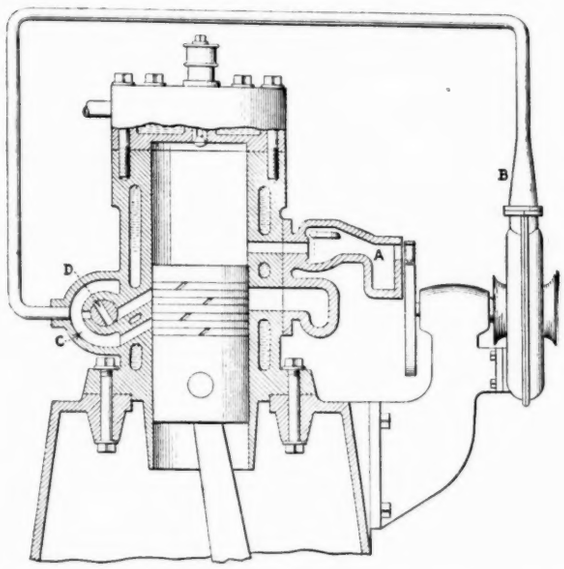


Fig. 4—The Moss application of exhaust-gas turbine

Approximate computations of the air required from the centrifugal compressor are as follows: The displacement of the reciprocating blower of the ship "Challenger" corresponds to 4 cu.ft. per min. per hp. A volumetric efficiency of about 87.5 per cent gives a round figure of 3.5 cu.ft. of actual air per minute per brake horsepower required from a centrifugal scavenger, and this figure has been used by some builders.

The amounts of supercharging ordinarily contemplated, say from 1 lb. per sq.in. to 5 lb. per sq.in. above the absolute pressure of the atmosphere, involve an increase of the amount of charge of from 6 to 30 per cent. If the clearance volume with supercharging is maintained at the same percentage as without, there will result an increase of compression pressure, and this has occurred in some of the cases previously mentioned. In most cases, however, the clearance volume has been increased in the same ratio as the absolute inlet pressure, so as to maintain the original compression pressure.

If the valve openings are properly retimed to suit supercharging, it is quite possible that the clearance space may be filled with a fresh charge and the exhaust gases entirely removed without discharge of air through the exhaust port. As the piston proceeds on the suction stroke with the exhaust valve fully closed and the inlet valve fully open, the cylinder (including the clearance space) will then be filled with a fresh

charge at a pressure below the pressure of the supercharger by the amount of the valve and port friction.

Some of the experiments have given an increase of power with Diesel engines greater than that theoretically computed by the principles of the preceding paragraphs, due to the fact that it has been found possible to burn greater percentages of oil. As is well known, the charge of oil injected into the air of a Diesel engine requires for theoretical combustion about half of the air actually in the cylinder. The amount of oil injected at maximum power is always made as great as is consistent with a clean exhaust. The absence of exhaust gases from the clearance volume facilitates the chemical act of combustion and the rapidity with which it spreads. The increased pressure with which the supercharged air enters the cylinder through the inlet valve also creates currents, so that there is certain to be pure air in the vicinity of the fuel-injection nozzle.

If in an unsupercharged and in a supercharged Diesel engine the same compression pressure and the same percentage of air charge is required for the combustion of the oil, there will be an increased amount of heat liberated with supercharging without any change in temperature. The surface of the combustion chamber in the two cases will be nearly the same, and hence there will be the same amount of heat lost to the jacket water during the early part of the stroke. The jacket-water loss will then be a smaller fraction of the total heat of combustion, which will result in a slight improvement in efficiency. If, however, the percentage of air that is used to burn the fuel is increased and the air excess diminished, there will of course be an increase of temperature and an increase of the jacket-water loss.

In case a Diesel engine of a given design is barely able to deliver its maximum power with no trouble with valves, cylinder heads or other parts, it would of course be futile to attempt supercharging of this kind. However, the fact that a number of engines are successfully operating with supercharging is prima facie evidence that Diesel engines can be designed to withstand the increase in the amount of power for a given cylinder displacement.

Fig. 4 shows a plan devised by the author which has been tested and has been made the subject of extended series of computations. An extra exhaust port is provided at the side of the cylinder somewhat in advance of the regular exhaust port. In this port is a check valve opening outward into a header that leads to the nozzle box of an exhaust-gas turbine. Four to six cylinders of a two-cycle engine must be connected to the header. When any one of the pistons passes the above-mentioned extra exhaust port during the expansion stroke, there will be sufficient pressure to open the check valve and pass a certain amount of exhaust gas to the nozzle box *A* and will drive the turbine *B*. This will continue until the piston begins to open the regular exhaust port. The pressure in the cylinder will then drop to a value below that in the nozzle box and the check for this particular cylinder will close. The exhaust will then pass out through the regular exhaust port and air will enter through the regular scavenging port *C* just as in an ordinary two-stroke-cycle engine.

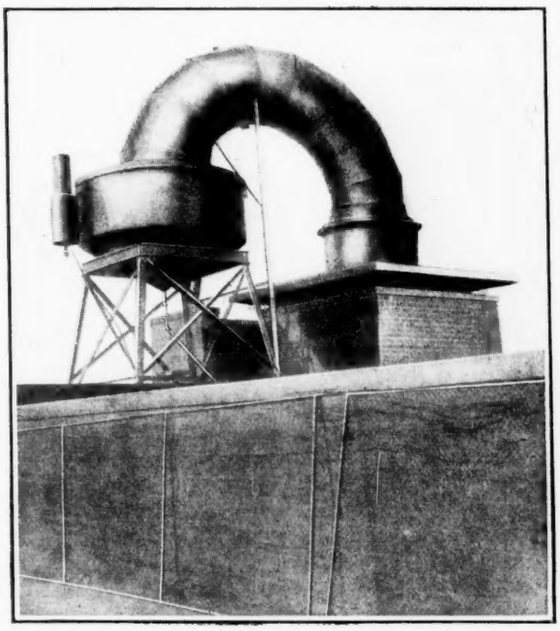
During the upward or compression stroke the pressure in the cylinder will be less than at the corresponding point in the down or expansion stroke, and the pressure in the nozzle box from other cylinders will prevent the check valve from opening. Hence, from the time that the check valve closes on the down stroke, the events in the cylinder will be exactly the same as for any two-stroke-cycle engine. With a six-cylinder engine there will be six such charges admitted during each revolution, and this will maintain a somewhat fluctuating pressure in the nozzle box. The magnitude of this pressure will, of course, depend upon the point in the stroke at which the extra exhaust port is placed.

It's a Stack Damper

By G. Grow

Visitors from the North and West are often perplexed at the sight on top of Southern buildings, of a curved pipe such as is shown in the illustration. This is a species of boiler stack damper peculiar to the South.

Instead of installing a damper in the boiler uptake or in the breeching, this damper is set at the top of



Draft is regulated by depth of water in tank at left end of "gooseneck"

the stack. It consists of a cylindrical steel tank lined with lead and partly filled with water. The top of the stack, or chimney, which in this particular plant is of brick, is provided with a hood so placed that there is a narrow air space between it and the stack. The top of the hood joins a curved steel pipe the other end of which passes down into the cylindrical tank.

The tank is provided with a float which is connected to an electrical contact device shown at the left of the tank. The device indicates the water level in the tank by lighting the proper globe of a row of electric lamps placed on a board in the engine room. If, for example, the water level is three inches from the end of the curved pipe, No. 3 lamp is bright.

In operation this distance between the gas outlet and the water is the means whereby the draft in the stack is regulated. It has been found that the lead lining is eaten out by the acid in the flue gases and a tile lining is now being used. While a simple damper at the boiler would probably be as satisfactory, the tank catches much of the cinder going up the stack.

How to Figure the Capacity of Chimneys

By J. G. MINGLE

THIS is the second of three articles, the first of which appeared in the issue of February 16. This article discusses the factors determining the area or diameter of a chimney.

BY THE capacity of a chimney is meant its ability to discharge gases. Capacity is measured in terms of pounds of gases passing per unit of time, usually expressed in pounds per second. Gases are formed and heated in the combustion chamber of the boiler at a certain rate, and these gases pass on through the boiler, the breeching, and finally up the chimney and out into the upper regions. The chimney must obviously discharge these gases at the same rate at which they are formed in the combustion chamber.

The equation for determining the rate at which the gases are generated in the combustion chamber is as follows:

$$W_g = \frac{C_g G}{3{,}600}\left[\left(11.52C + 34.56\left(H - \frac{O}{8}\right) + 4.32S\right) R_a + C + \left(H - \frac{O}{8}\right) + S\right] \quad (1)$$

in which

W_g = Weight of products of combustion (gases), lb. per sec.;
C_g = Rate of combustion, lb. of fuel burned per sq.ft. of grate surface per hour;
G = Total grate surface, sq.ft.;
C, H, O and S = Weight of carbon, hydrogen, oxygen and sulphur, respectively, lb. per lb. of fuel;
R_a = Excess air ratio, or ratio of air actually used to that theoretically required.

The primary equation for determining the capacity of a chimney is as follows:

$$W_p = 33.43\,\frac{P_o W_c A V}{T_c} \quad (2)$$

or

$$W_p = 16.43\,\frac{B_o W_c A V}{T_c} \quad (3)$$

in which

W_p = Weight of chimney gases passing, lb. per sec.;
A = Cross-sectional area of chimney, sq.ft.;
V = Working, or actual, velocity of the chimney gases, ft. per sec.;
T_c = Absolute temperature of the chimney gases, deg. F.;
B_o = Atmospheric pressure, in. of mercury;
P_o = Atmospheric pressure, lb. per sq.in.;
W_c = Density of the chimney gases at 32 deg. F. and sea-level atmospheric pressure.

In designing a new or projected chimney, it is a matter of fact that a different combination of height and diameter will be obtained for each different value of chimney gas velocity assumed. An equation can be deduced for a velocity that will result in a combination of height and diameter whose relative cost will be least, all other conditions being constant for the moment. This equation will appear in a later article. The chimney-gas velocity that was used in determining the size of the chimney is called the working velocity and should be the velocity used in determining the actual capacity as given by equation (2). When this velocity is increased, the chimney is being operated, or worked, above its actual rated capacity, and when decreased, the chimney is being operated below its actual capacity. In other words, when $W_g = W_p$, the chimney is operating at its actual capacity; when $W_g < W_p$, the chimney is being operated below its actual capacity, and when $W_g > W_p$, the chimney is being operated above its actual capacity.

Let it be assumed, for example, that a chimney 200 ft. in height and 10 ft. in diameter was designed for a chimney-gas velocity of 30 ft. per sec. Let it also be assumed that the density of the chimney gases is 0.084 lb. per cu.ft. at 32 deg. F., that the temperature of the chimney gases is 550 deg. F., and that the elevation of the plant is such that the atmospheric pressure is equal to 29 in. of mercury. It will be noted that these data correspond to those of the previous article of this series.

From equation (3) of the present article,

$$W_g = 16.43 \times \frac{29.00 \times 0.084 \times 78.5 \times 30}{1009.6} = 93 \text{ lb. per sec.}$$

Now when the furnace is generating gases at the rate of 93 lb. per sec., the gases will pass into and up the chimney at this rate, with a velocity of 30 ft. per sec. If, however, gases are generated at the rate of 130 lb. per sec., they must of necessity be accommodated by the chimney at this same rate, and the velocity will be increased to 42 ft. per sec. so that the chimney will be worked above its actual capacity, or be overloaded. On the other hand, if gases are generated at the rate of only 60 lb. per sec., the velocity will be only 16.5 ft. per sec. and the chimney will be worked below capacity.

Definition of Chimney Capacity

The actual capacity of a chimney may be defined as the quantity of gases that will flow at the velocity that leads to the minimum cost of chimney. This is obviously the rational way to express capacity.

When a chimney is worked above its actual capacity, both the loss of draft due to velocity and the loss due to friction are increased and the available draft is correspondingly decreased as a result. The opposite is true when the chimney is worked below its actual capacity. It is not good practice to operate a chimney above its rated capacity. It follows that a projected chimney should be designed for the maximum conditions to which it ever will be subjected.

An example will illustrate this point. In the example previously stated, for an outside air temperature of 60 deg. F. the theoretical draft of the chimney is equal to 1.321 in. of water. When 93 lb. per sec. of gases are

flowing at a velocity of 30 ft. per sec., the loss of draft due to velocity is equal to 0.106 and the loss due to friction 0.122 in. of water, whence the available draft equals

$D_a = 1.321 - (0.106 + 0.122) = 1.093$ *in. of water*

Assume that the chimney is overloaded and that it is passing 130 lb. per sec. of gases at a velocity of 42 ft. per sec. Then the loss due to velocity is equal to 0.207 and the loss due to friction 0.239 in. of water. In this case the available draft equals

$D_a = 1.321 - (0.207 + 0.239) = 0.875$ *in. of water*

In other words, when the load on the chimney is increased 40 per cent, the available draft is decreased 20 per cent.

Now assume that the chimney is worked below its actual capacity and that it is passing 60 lb. per sec. of gases at a velocity of 19.5 ft. per sec. Then the loss due to velocity is equal to 0.044 and the loss due to friction 0.051 in. of water, and the available draft equals

$D_a = 1.321 - (0.044 + 0.051) = 1.226$ *in. of water*

In other words, when the load on the chimney is reduced 35.5 per cent, the available draft is increased 12.2 per cent.

Capacity Varies with Gas Temperature

The capacity of a working chimney increases as the temperature of the chimney gases increases until a certain maximum is reached, after which the capacity decreases. The chimney-gas temperature at which a chimney will attain its maximum capacity is given by the equation,

$$T'_c = \frac{2T_aW_c}{W_a} \qquad (3)$$

Thus for an outside air temperature of 60 deg. F. and a chimney-gas density of 0.084 lb. per cu.ft. at 32 deg. F.,

$$T'_c = \frac{2 \times 519.6 \times 0.084}{0.0807} = 1{,}081$$

Whence the maximum capacity will be attained at a chimney gas temperature of

$$1{,}081 - 460 = 621 \text{ deg. F.}$$

In other words, under the conditions assumed, the least diameter will be required for a new chimney when the temperature of the chimney gases is assumed at approximately 621 deg. F.

It has been the custom to express the capacity of a chimney in terms of the equivalent horsepower of the boilers it serves. This is extremely dangerous practice. It is ridiculous to speak of the horsepower, or the horsepower equivalent, of a chimney. Any relation expressed between the capacity of a chimney and the horsepower of the boilers is only approximate. This relation is usually expressed by the equation,

$$H.P. = KA\sqrt{H} \qquad (4)$$

in which

$H.P.$ = Horsepower of chimney corresponding to horsepower of the boilers;

K = A constant depending upon the following factors: (1) Temperature of the chimney gases, (2) density of the chimney gases, (3) rate of combustion (4) amount of air required to burn one pound of coal, (5) total grate surface of boilers;

A = Area of chimney, sq.ft.;

H = Height of chimney, ft.

The factor K is usually assumed at 2.5. However, in ordinary practice the chimney-gas temperature will vary between 350 and 750 deg. F., the density of the chimney gases between 0.082 and 0.088 lb. per cu.ft. at 32 deg. F., the rate of combustion between 10 and 50 lb. per sq.ft. of grate surface per hr., and the air required to burn one pound of coal between 8 and 20 lb. Considering these limits, the value of K will vary between 1.5 and 3.5, a variation of over 40 per cent from 2.5, the mean value. This shows the futility of attempting to include all these variables in one factor for even average working conditions.

Rules for Using the Wire Table

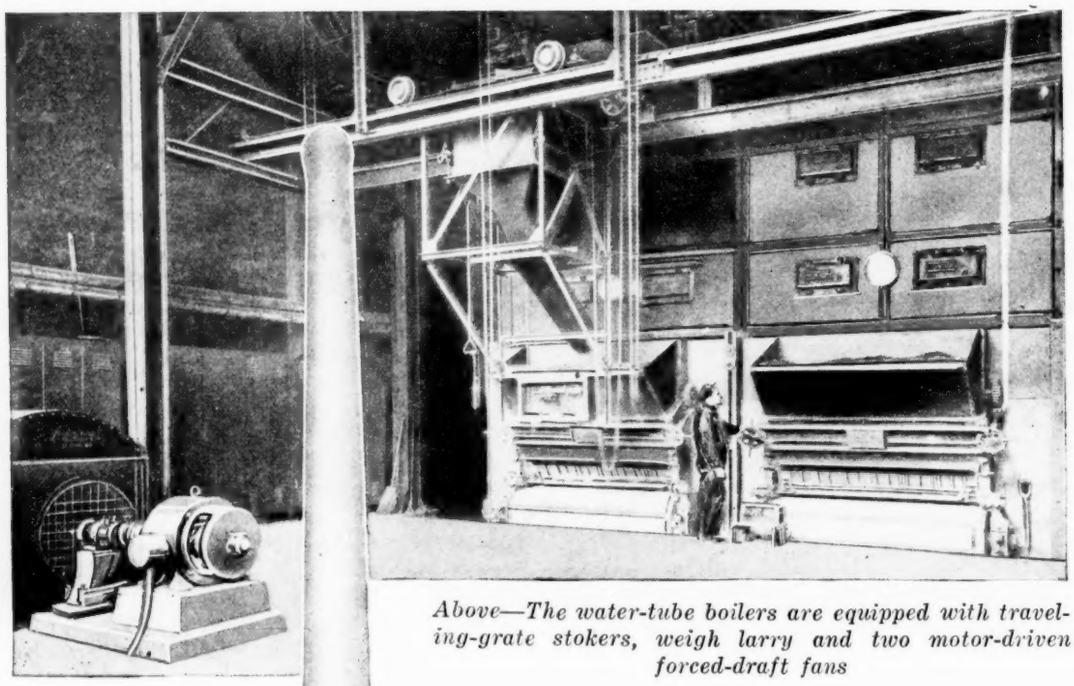
In this country the B. & S. (Brown & Sharpe) wire gage is the one used for most all electrical wire. This gage has come to be known as the American Wire Gage (A. W. G.). It was first devised in 1875 by J. R. Brown, one of the founders of the Brown & Sharpe company. Previous to this the Birmingham wire gage was in extensive use in this country along with a number of other gages, and as a result considerable confusion existed, but the general adoption of the B. & S. gage to electrical work has eliminated these misunderstandings.

A practically constant relation exists between successive sizes in the American Wire Gage, so that if data for one wire are known, those for the other sizes may be worked out. It happens that for a No. 10 wire the data can be more easily remembered than for almost any of the other sizes. For example, a No. 10 wire has a cross-sectional area of approximately 10,400 circ. mils. The square root of this value will give the diameter of the wire, or it may be taken as about 100 mils, or 0.1 in. A 1,000-ft. length weighs about 31.5 lb. bare, and therefore there are about 31.5 ft. per pound. Every three sizes change in the gage numbers, the cross-section area either increases or decreases by two, depending on whether the sizes are increasing or decreasing. Applying this rule, it will be found that a No. 7 wire has about twice the cross-sectional area of a No. 10, or 10,400 $\times$ 2 = 20,800, and a No. 13 has about one-half the cross-sectional area of a No. 10, or 10,400 $\div$ 2 = 5,200 circ.mils. The actual figures are 20,820 and 5,178 respectively.

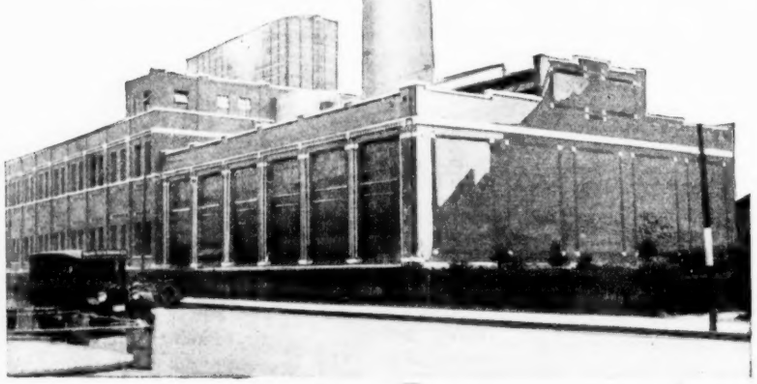
One size larger or smaller may be obtained approximately by multiplying or dividing by 1.25. That is, a No. 6 wire would have a cross-sectional area of 20,800 $\times$ 1.25 = 26,000 circ.mils, compared to the actual figures of 26,250. A No. 8 wire will, according to the rule, have an area of 20,800 $\div$ 1.25 = 16,640 circ.mils, where the wire table gives 16,510 circ.mils.

The diameter of a round wire doubles or halves every sixth size. For example, if the diameter of a No. 10 wire is taken as 0.1 in., a No. 4 will have a diameter of 0.1 $\times$ 2 = 0.2 in., and a No. 16, a diameter of 0.1 $\div$ 2 = 0.05 in. The figures given in the table are 0.2043 and 0.05082 respectively. Multiplying or dividing the diameter by 1.14 will give the next larger or smaller size.

For a given length the weight of a wire increases as its cross-sectional area. Therefore if the area doubles or halves every three sizes, the weight will do likewise. A No. 7 wire has about double the circular-mil area of a No. 10. Then, as a No. 10 bare wire weighs about 31.5 lb. per 1,000 ft., a No. 7 wire will weigh 31.5 $\times$ 2 = 63 lb., against 63.02 given in the wire table.



Above—The water-tube boilers are equipped with traveling-grate stokers, weigh larry and two motor-driven forced-draft fans

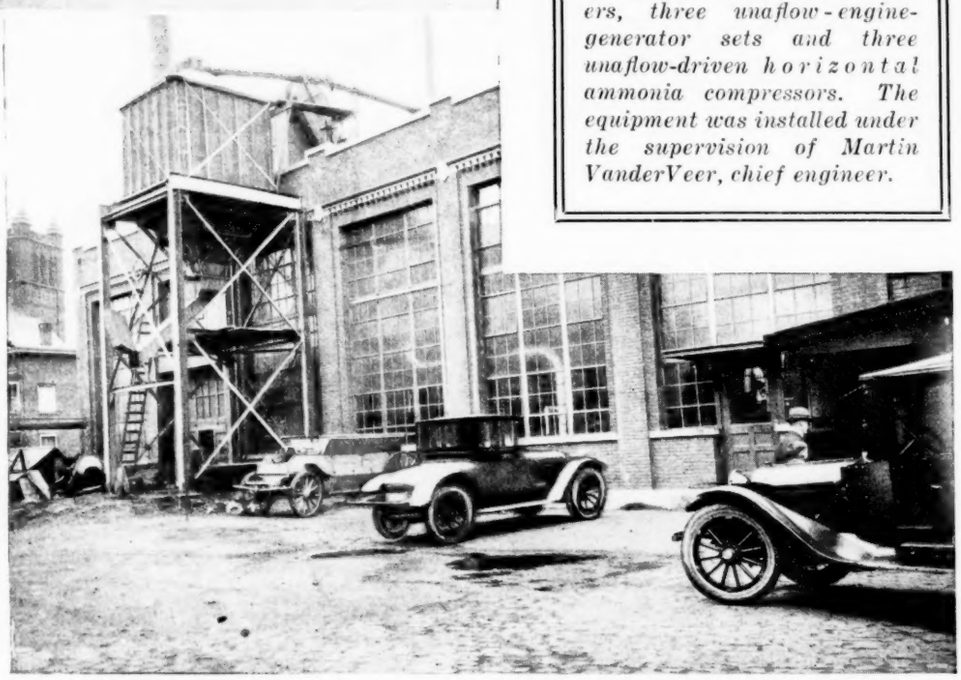


Above—High stack maintains adequate draft at uptake

Architectural features have been given careful consideration

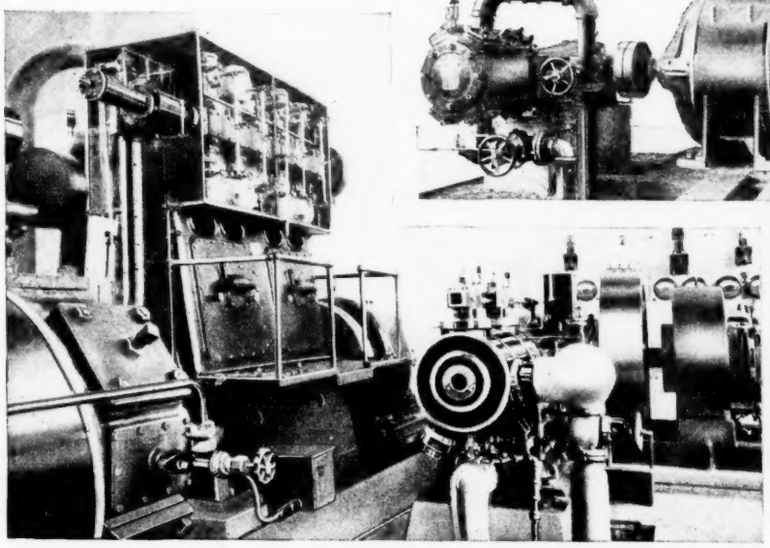
Up-to-Date Equipment at Hygienic Ice Plant

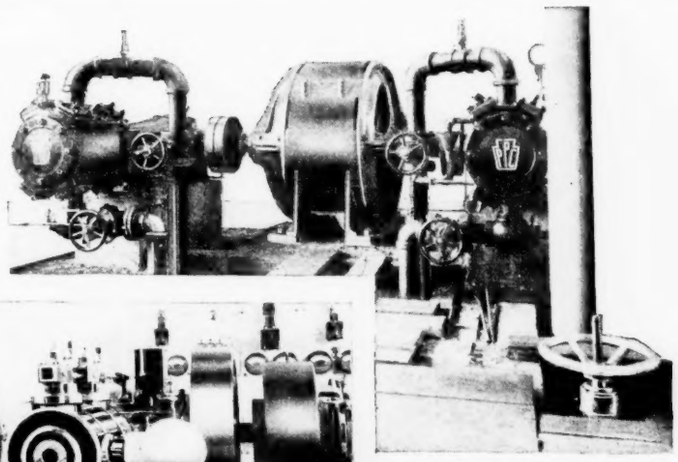
An unusually interesting plant in many ways is that of the Hygienic Ice Co., New Haven, Conn. Its principal equipment includes two water-tube boilers burning buckwheat anthracite with forced draft on traveling-grate stokers, three unaflow-engine-generator sets and three unaflow-driven horizontal ammonia compressors. The equipment was installed under the supervision of Martin VanderVeer, chief engineer.



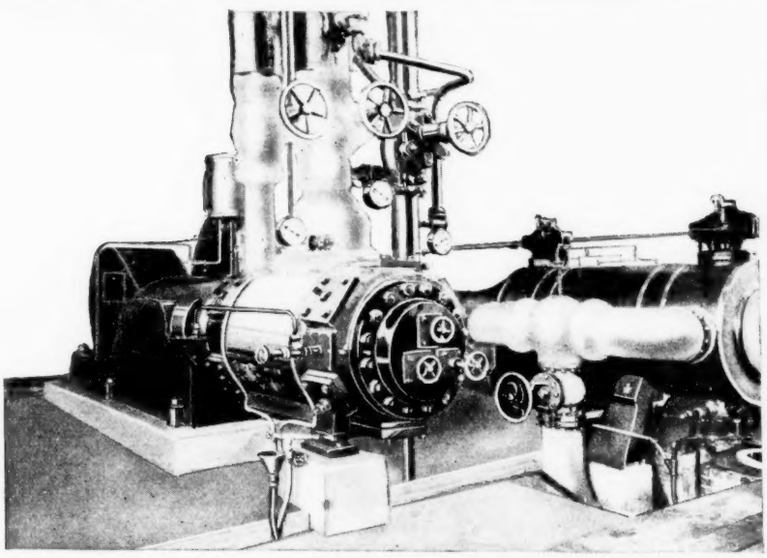
Right—Ashes are discharged to trucks from an elevated hopper

Right—Either unit of duplex air compressor may be disconnected



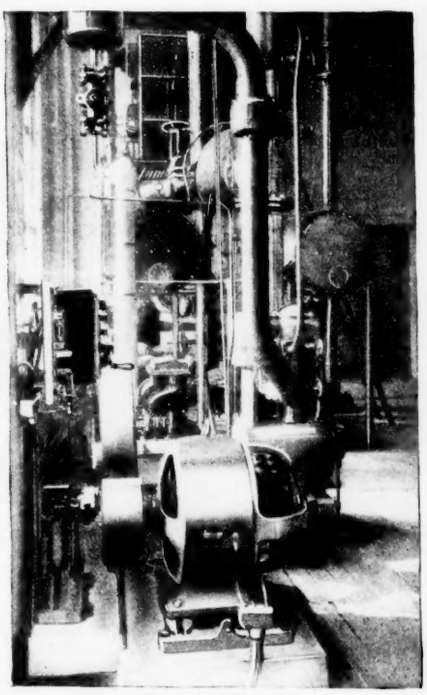


Left—Vertical, 4-cylinder unaflow engine driving 250-kw. direct-current generator. On right is 50-kw. unaflow generating set

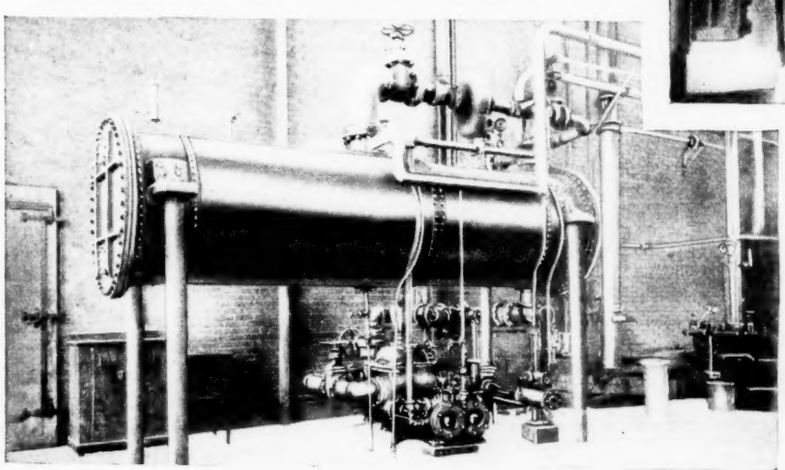


Above—One of three horizontal unaflow-engine-driven ammonia compressors

Note handwheels regulating compressor clearance.



Above — Condensing equipment and metering open heater. Small pump-out unit in foreground



Left — Water heater for plant heating system

Avoiding Mistakes in the Refrigerating Plant*

By H. G. VENEMANN

TO LEARN quickly how to avoid mistakes in the refrigerating plant, one of the best ways is to review and analyze the errors of others. Following this line of thought, the errors of two different plants will be reviewed in the hopes that the recital may prove of value.

Getting Out of the Rut

A young man recently graduated from an engineering school, had succeeded an old experienced, practical engineer of a plant that had one of the first absorption ice-making units ever installed, and at that time had been

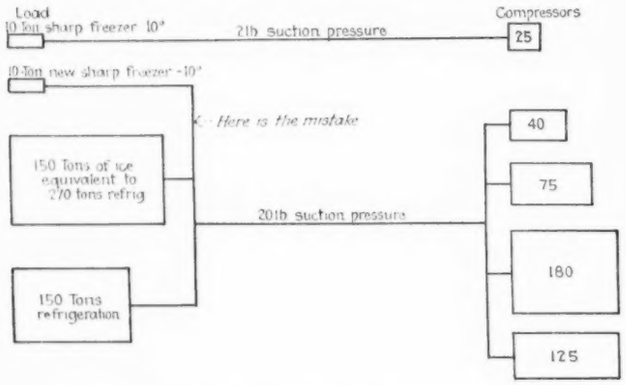


Fig. 1—Original load distribution of compressors

in service about twenty-four years. The equipment was in dilapidated condition, and much of it obsolete. It consumed nine tons of lignite slack coal per day to produce eighteen tons of ice. The two-to-one ratio of ice to coal did not compare favorably with certain claims this young engineer had seen published, so he proceeded to make a thorough analysis of the steam consumption used in the generator, liquor pump, water pump and other steam-driven units, in addition to studying the piping in the tanks, checking the feet of evaporating surface, the circulation of brine, and other matters.

Water Meter Installed

After numerous calculations of piston displacements, horsepower developed, and the probable steam requirements of the various units, a water meter installed on the feed line to the boilers disclosed an evaporation of 40 tons of steam per day—not bad evaporation considering the grade of the fuel and the type of boilers, but too much steam going to waste for eighteen tons of ice. After careful study certain changes in the plant layout were recommended, but his prescription did not take well with the owner, who would not consider spending $1,000 on improvements. It was his opinion that the plans would not work, because, if they had been worth while, the old engineer would have tried them out years before. The young man was looked upon as a theoretical engineer trying to put into effect some of his book learning contrary to the better judgment and prestige of the former practical operating engineer.

Changes and Replacements

For several months things ran along as usual, when late in November some rusted, pitted pipes in the condenser and absorber burst, requiring replacement. This gave an opportunity to work in some other changes during the winter months. New grates were installed under the boilers with fine holes instead of the $\frac{3}{4}$-in. bars, and they were dropped 18 in. lower than before. The fire wall in the combustion chamber was reset to insure complete combustion of the coal and gases, air infiltration through the brick setting was stopped and 20 ft. added to the smokestack. The boiler tubes and tube heads were thoroughly cleaned. In the freezing tank the headers were changed to the gravity feed system and additional baffles were installed to cause a positive brine circulation at increased velocity. A new distilling and reboiling system also was obtained. These improvements cost in the neighborhood of $1,500, but enabled the plant to produce from 22 to 24 tons of ice a day by burning only six tons of fuel, effecting a yearly saving of 900 tons of coal, worth at that time, about

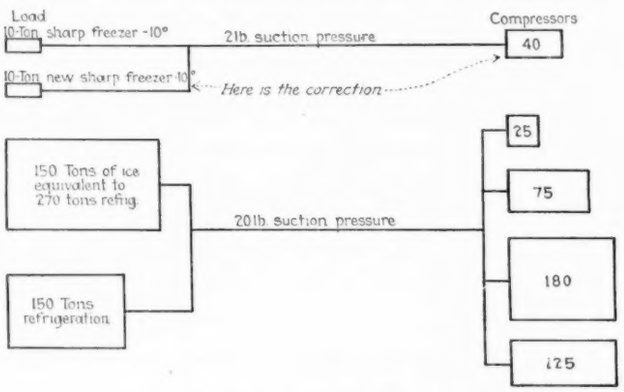


Fig. 2—Showing how the "hook up" was corrected

$1.50 a ton. The ice production was increased 1,500 tons, netting an average profit of $2 a ton, or a total benefit from coal and ice of $4,350 a year. It might be of interest to state that this plant is now thirty-five years old and still in service.

Haphazard Design

A certain operating engineer had grown up in a plant that had made rapid progress, starting originally with a 20-ton ice-making unit and a few cold-storage rooms, and developing within a period of twenty years into a plant that manufactured 150 tons of ice a day, and with cold-storage facilities that covered more than a block.

*From a paper read at the sixteenth annual convention of the National Association of Practical Refrigerating Engineers, Detroit, Dec. 8-12, 1925.

As an example of a highly skilled operating engineer with mechanical ability, this man was par excellence. In fact, he had the reputation of being the best in that part of the country. Unfortunately, however, he did not possess that scientific training necessary to guide him in the proper selection of new equipment, nor the engineering foresight and ingenuity for planning future expansion. The company and plant had developed faster than the man.

Five steam-driven compressors, all of different makes and sizes, had been set up in the engine room in whatever space that was available, but with no thought of the future. Steam-driven pumps of varied type were laboring to lift water on a 22-in. vacuum from an improvised water system 300 ft. away. One freezing tank containing 300-lb. cans had nothing in common with its 400-lb. neighbor. Automatic stokers, inappropriate for the type of boilers and grade of fuel in use, were burning too much coal. The coal bin had been located thoughtlessly at the extreme end of the railroad siding, making it compulsory to call on the yard engine to move the "empty" before a new car could be set, frequently resulting in nervousness for fear that the bin would be depleted before a new car could be located. A circuitous tunnel wended its tortuous path from the engine room, through the rear of the boiler room, dipping down below one of the cold-storage buildings, and thence zigzagging its way under a thoroughfare, and terminating in the basement of another cold-storage building a block away.

A Younger Man Takes Charge

Such was the condition of a plant that had just grown without a directing leader. Realizing the seriousness of the situation, the management held the old engineer responsible for their predicament and superseded him by a younger man. In this plant a serious mistake had been made in the use of the machines. Four compressors with a combined refrigeration capacity slightly in excess of 420 tons had been working together on the high-temperature duty, including ice-making, creamery work, and all rooms having temperatures of 20 deg. and over. The suction pressure had been running about 20 lb. and the discharge pressure 185 lb. A fifth compressor of about 25 tons capacity had been working independently on the sharp freezer load at 2 lb. suction pressure, all as indicated in Fig. 1.

A new sharp freezer had been built just prior to the change in chief engineers and, realizing that the 25-ton machine was inadequate to take care of any additional load, this new sharp freezer had been piped heavily and connected into the high-pressure suction line. The new chief engineer had been given instructions by the management to maintain a temperature in this room of 5 deg. below zero. He immediately notified them that to attempt such a thing would cost the company hundreds of dollars a day, by reducing the daily ice output from 150 tons to less than 40. They could not understand why the addition of a 10-ton sharp-freezer load could possibly cause them to lose over 100 tons of ice a day. Scientific explanations and reasons by the chief were of no avail as to why the decreased weight of the gas at low pressure would necessarily decrease the compressor capacity in the same relative proportion, and why the volumetric efficiency would also be less, thus compounding the losses. The management could see only that the small 25-ton compressor had been pulling all the other freezers, and it was their thought that the large machines would lose only 25 tons refrigeration in handling this new freezer.

The new chief informed them that the "hook-up" was wrong, and ordered fittings to enable him to make connections into the 5-in. low-pressure suction line. In the meantime he proceeded to demonstrate his theory. He reduced the suction pressure from 20 to 15 lb. and dropped the freezer-room temperature to 15 deg. F. Had the piping not been exceptionally heavy, it probably would not have been colder than 22 deg. F. This reduction of suction pressure was effected by cutting down the expansion valves on the ice-freezing tanks, for the compressors did not have sufficient surplus capacity to enable them to keep it lower than 20 lb. normally, and they were already operating at safe maximum speeds.

This reduction in pressure of only 5 lb. reduced the refrigeration tonnage from 420 to 352, and since the cold-storage load had to be maintained, the ice tanks had to absorb the total loss, resulting in decreasing the ice output 38 tons a day, from 150 to 112 tons.

Reference to the accompanying table will show clearly the daily loss of ice by decreasing the suction pressure. Had the engineer followed orders and maintained a temperature of —5 deg. in the new sharp freezer, he would have been compelled to drop the suction pressure to below 4 lb. and would have lost over 112 tons of ice each 24 hours.

SHOWING EFFECT OF SUCTION PRESSURE VARIATION ON PLANT CAPACITY

Suction Press., Lb. Gage	Suction Temp., Deg. F.	Room Temp., Deg. F.	Theoretical Displ., Cu. In. per Ton per Min.	Vol. Eff. at 185 Lb. Discharge	Actual Displ., Cu. In. per Ton per Min.	Per Cent Capacity With 20 Lb. Suction As 100 Per Cent	Normal Tonnage of Four Compressors	Fixed Cold Stor. Ld., Tons Refrig.	Balance Available for Ice Making	Tons Ice Made	Tons Ice Lost per 24 Hr.
20	+ 6.1	+22	5,904	80	7,380	100	420	150	270	150	None
15	— 0.3	+15	6,864	78	8,800	83.8	352	150	202	112	38
12	— 7.7	+ 7	7,605	76	10,000	73.8	310	150	160	89	61
8	—11.0	+ 3	8,895	74	12,000	61.5	258	150	108	60	90
5	—16.5	— 3	10,212	72	14,200	52.0	218	150	68	38	112
2	—22.6	—10	11,960	70	17,100	43.1	181	150	31	17	133

Instead he asked for a few days of grace, and as soon as the fittings arrived, cut into the 5-in. low-pressure suction line with this new freezer and by means of bypass valves shifted the 40-ton compressor onto the low-temperature work, changed the 25-ton machine onto the high-temperature work, and secured the desired results without losing more than 8 tons of ice per day. Fig. 2 shows the new arrangement. This new chief knew the properties of ammonia and scientifically applied his knowledge.

The purpose of taking leads of bearings is to determine the amount of clearance. The method of taking a lead is to remove the cap and lay a piece of soft lead wire, No. 16 or 18 B.w.g., inside of the cap or along the journal parallel to the axis of the bearing; or lay one piece of the lead wire across the axis at the middle of the bearing and one at either end. The cap is then set down hard on the liners, and the lead wire becomes compressed to a thickness that is equal to the clearance. The leads thus afford means of gaging the clearance that is obtained when the bearing is set with the same liners or, by comparison with the thickness of a lead previously taken at the same part of the bearing, the difference of thickness of the leads measured with a micrometer, gives the amount of wear that has taken place.

Electric Power Development in Chicago District*

By WILLIAM S. MONROE†

A COMPREHENSIVE review, tracing the advance step by step, as indicated by succeeding stations, with an outline of plans for the future that will provide an interconnected generating capacity approximating six million kilowatts.

THE first central station in Chicago was built by the Chicago Edison Co., on West Adams Street, in 1887. The first important expansion was the building in 1894 of the famous old Harrison Street Station, which had an initial capacity of about 640 kw.

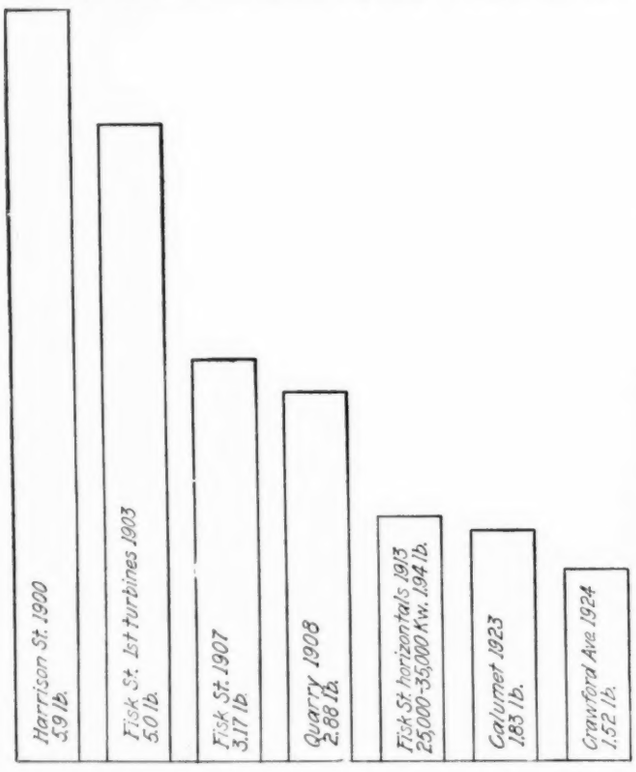


Fig. 1—Coal consumption of stations built at different periods

and an Edison three-wire system of 220-volt, direct-current transmission in which the copper mains used were unprecedented at that time.

An important step toward the consolidation of the power supply and the increase in area that could be reached from the power station was the application in 1897 of 2,300-volt three-phase alternating current to the transmission of energy for an Edison three-wire system. This was the first application of its kind and was made in connection with the Harrison Street Station by means of rotary converters and transformers at the generating and receiving ends of the system.

A great impetus was given to the central-station industry by the introduction of the steam turbine,

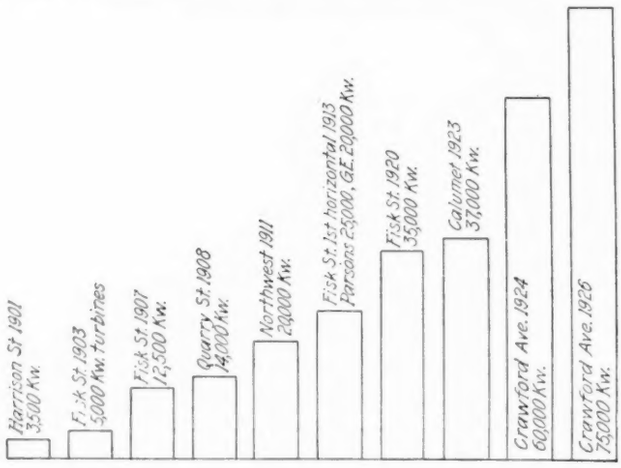


Fig. 2—Size of generating units installed at different periods

Chicago having the distinction of building the first central station designed from the start for steam turbines. This was the now historic Fisk Street Station, in which the first machine, a 5,000-kw. vertical Curtis turbine, went into operation Oct. 2, 1923. When the station was laid out in 1902, it was thought that fourteen of these units having an aggregate capacity of 70,000 kw., would take care of Chicago's requirements for ten years, but by 1911 Fisk Street Station contained ten vertical turbines of 12,000 kw. capacity each, the Quarry Street Station had been built with six units of 14,000 kw. and the Northwest Station contained two 20,000-kw. 25-cycle units, giving a total of 244,000 kw. nine years after the Fisk Street Station had been laid out. The eighteen vertical turbines in these three stations are still in operation as reserve and peak-load units.

By 1911 the Chicago load was growing at the rate of about 25,000 kw. per year and the cost of coal was going up. These facts led to an effort to make a substantial improvement in station efficiency. In 1912 a 25,000-kw. Parsons unit was installed in an extension to the Fisk Street Station. It went into service in June, 1914, and was the first horizontal turbine in any of the Commonwealth Edison stations. It was followed immediately by a 20,000-kw. horizontal turbine of American make, and these two units, in comparison with previous installations, showed a reduction of about

*Abstract of paper read before the Midwest Power Conference, Chicago, Jan. 27, 1926.

†President, Sargent & Lundy.

20 per cent in fuel consumption per unit of output, making the coal consumption for the first time below 2 lb. per kilowatt-hour.

Between 1914 and 1919 four turbines of 30,000 and 35,000 kw. capacity were added to the Northwest Station, and two to Fisk Street. In 1917 a small station was built at Joliet for the Public Service Company of Northern Illinois, with two 10,000-kw. units which operated at 300 lb. steam pressure at the turbine and was the first station to run on anything over 250 lb. pressure.

While this power-station development was going on, the transmission and distribution systems were greatly expanded, reaching out in continually widening areas from the power stations, until in 1920 there were 162 substations.

In 1921 the Calumet Station was put into operation with two 30,000-kw. units operating on 300-lb. steam pressure. This station now has six units with a total capacity of 187,000 kw.

Efficiency of Crawford Avenue Station

In the latter part of 1922 design was started on the Crawford Avenue Station in which a special effort was made toward a distinct improvement in power-station efficiency. The high steam pressure employed and the many special features of this station have been given publicity previously in these columns.[1] It will be recalled that the first installation at this station consisted

Fig. 3—Fuel economy of total system of Commonwealth Edison Co. over period of years

of three units of 50,000 and 60,000 kw. capacity and that a 75,000-kw. unit is now on order.

Analysis of the operating cycle of the plant indicates that with the low-grade Illinois coal that was being used, and given a good load condition for all the turbines, a plant efficiency of 1½ lb. of coal per kilowatt-hour should be obtained, this being equivalent to about 15,000 B.t.u. per kw.-hr. In operation this economy already has been approximated.

[1]See *Power*, June 16, 1925, pp. 936 to 944.

In considering these figures it must be kept in mind that the Crawford Avenue Station, like all the Chicago stations, is handicapped in fuel efficiency by the low-grade coal that is used. This coal contains 15 per cent moisture and 15 per cent ash. The iron content is about 2 per cent, the sulphur 4 per cent and the hydrogen, not including that in the moisture, is 4 per cent. The fusing temperature of the ash is low, and the coal is much slower to ignite than most coals, even those of similar analysis. The characteristics of the ash create a severe slag condition in the furnace and on

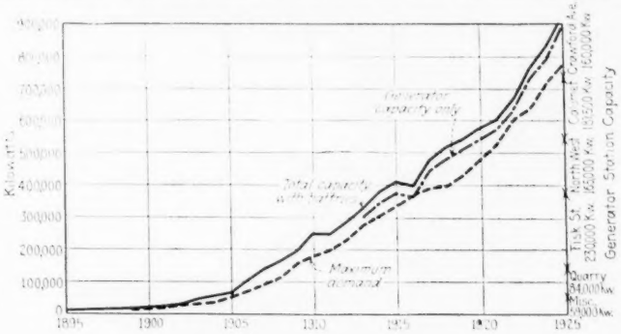


Fig. 4—Maximum load and generating capacity of Commonwealth Edison Co. from 1895 to 1925

the tubes of the lower part of the boiler, which contributes to limit both the capacity and efficiency that can be obtained from the boilers and furnaces. With high-grade Eastern coal the Crawford Avenue Station should operate at between 14,000 and 14,500 B.t.u. per kw.-hr., as against 15,000 to 15,500 B.t.u. with central Illinois coal. These figures apply to stoker firing, and with pulverized coal the B.t.u. per kilowatt-hour in any case should be 400 or 500 B.t.u. lower.

Station Efficiency Improvement Since 1900

Improvement in station efficiency in the Chicago district since 1900 is shown in Fig. 1, and the advancement in the size of the units in Fig. 2. In Fig. 3 are shown the pounds of coal per kilowatt-hour, the cost of coal per ton and the cost of coal per kilowatt-hour for each year since 1900. These figures are for the entire Commonwealth Edison system, and it is interesting that from 1910 to 1920 the pounds of coal per kilowatt-hour were reduced from 2.98 to 2.47 and from 1920 to 1925 from 2.47 to 2.06. In 1910 the average coal rate for the entire system was 3 lb. per kilowatt-hour, and last October was the first month in which it went below 2 lb. From the diagram it will be seen that since the beginning of the World War the cost of fuel per unit of output has been far more dependent upon the cost of coal than on the fuel efficiency of the power stations, and undoubtedly this will continue to be the case.

There are now five major power stations in the City of Chicago, and several small ones, with a total capacity of 885,500 kw., and they transmit energy to a total of 257 substations, by underground cables at 9,000 and 22,000 volts on the 25-cycle system and at 12,000, 20,000 and 30,000 volts on the 60-cycle system. The power stations are all interconnected by underground tie-lines at the same voltages. This interconnection is now being extended to take in the stations in the districts around Chicago, including those of the Public Service Company of Northern Illinois, the Northern Indiana Gas & Electric Co. and the Midland Utilities

Co. The stations indicated supply electric energy to an area of about 5,400 square miles, and the district has a frontage on Lake Michigan of 92 miles, running from Waukegan on the north to Michigan City on the southeast. Within two or three years these stations will all be connected together and with the Chicago stations by a system of 130,000-volt tie-lines running all around the city.

The first sections of the high-tension outer system are already in service. One line runs from Waukegan to the north limits of the city and from there is being connected to the Northwest Station by 130,000-volt underground cables. Another 130,000-volt tower line runs from Joliet to Calumet and extends across northern Indiana to Aetna, about two miles east of Gary, and is now being extended to Michigan City, where a large new station is to be built on the lake front. By the end of the current year this line will be further extended to connect to the Twin Branch Station of the American Gas & Electric Co. east of South Bend, Ind. During the coming year Joliet will be connected to Crawford Avenue, and this line soon after will be extended outside the city limits and run north to connect at Crystal Lake with a line running west from Waukegan.

This high-tension circuit with the great power stations connected to it will give the City of Chicago and the great industrial district growing up around it in Illinois and northern Indiana a source of reliable and cheap electric power second to none in the world, and will be the nucleus of a superpower system which already reaches (with varying voltages) from northern Wisconsin to southeastern Kentucky and within a year or two will have Chicago connected to Pittsburgh by a continuous tower line at 130,000 volts.

Growth of Station Capacity

The growth of the Chicago load and power-station capacity since 1900 is shown graphically in Fig. 4. On Dec. 23 last, the peak load in Chicago was 780,500 kw., that of the Public Service Company was 113,600 kw., and of the northern Indiana district, 38,500 kw., making a total for the entire Chicago district of 932,600 kw. By next year the combined load will have passed

POWER STATION CAPACITY CHICAGO DISTRICT

	Capacity, Kilowatts		
	1926	1930	Ultimate
Commonwealth Edison Co.			
Fisk Street	230,000 (rebuilt)	282,000 (rebuilt)	350,000
Quarry Street	84,000	84,000	84,000
Northwest	165,000 (rebuilt)	205,000 (rebuilt)	205,000
Calumet	187,500	210,000	210,000
Crawford Avenue	235,000	410,000	750,000
Small stations	59,000	7,500	.....
Total comm. Ed. Co	960,500	1,198,500	1,599,000
Public Service Co. of N. Ill.			
Waukegan	60,000	160,000	500,000
Joliet	50,000	50,000	150,000
Blue Island	48,500	48,500	48,500
Small stations	16,040	16,040	.....
Total P.S. Co	174,540	274,540	698,500
Northern Ind. Region			
East Chicago	28,000	28,000	.....
Michigan City	.....	60,000	600,000
State line	.....	200,000	1,000,000
Small stations	1,125	19,825	.....
Total N. Ind.	29,125	307,825	1,600,000
Total capacity of district	1,164,165	1,780,865	3,897,500

1,000,000 kw., and it is likely to reach 1,500,000 kw. by 1930 and 2,000,000 kw. by 1934.

The accompanying table shows the power-station capacity at the present time, what it will probably be in 1930, and also the ultimate capacity that eventually may be developed on the power-station sites on which work is now in progress. The ultimate capacity on all these sites is nearly 4,000,000 kw., and there are included, besides Crawford Avenue and Waukegan, the new "State Line" site on Lake Michigan immediately east of the Illinois-Indiana state line and the new station on the lake shore at Michigan City. Turbines already have been ordered for the first installation at Michigan City, and this station will be developed ultimately to a capacity of about 600,000 kilowatts.

The power station at State Line will be built on land that is now being filled in out in Lake Michigan. It is planned to develop here a station of 1,000,000 kw. capacity, and the first unit probably will be a compound unit with three turbines and generators having a combined capacity of 200,000 kw. The plans contemplate five such units on the site. This station will have many new features, and so far as the ultimate cost of power is concerned, in all probability will be as much of an advance on Crawford Avenue as Crawford Avenue is in comparison to Calumet Station.

Besides these sites, the Commonwealth Edison Co. owns a tract of land on the Drainage Canal about four miles downstream from the Crawford Avenue Station, on which another station can be developed about as large as Crawford Avenue, or 750,000 kw. The public Service Co. owns a power station site on the opposite side of the Des Plaines River from the present Joliet Station, on which can be developed another station of 1,000,000 kw. capacity. So it is safe to say that on the sites in and around Chicago, now owned by the associated companies, there ultimately will be developed a total capacity of nearly 6,000,000 kw. The load in the Chicago district is likely to require that capacity some time between 1945 and 1950, but long before that time power will be transmitted into Chicago from the Central Illinois coal fields.

Cleaning Motor Windings

Most electric motors operate under conditions where the windings and ventilating ducts accumulate more or less dirt, dust and oil. Periodically, depending upon the conditions, the motors should be given a good cleaning. Dirt and oil fill up the air ducts and cause the temperature of the machine to increase and oil deposits on the windings tend to destroy the insulation.

As a preliminary to the cleaning process, after the motor has been taken apart, compressed air at about 40-lb. pressure should be used to blow all the dust and dirt possible off the windings and out of the ducts. After this has been done, if gummy deposits are on the winding, it will be necessary to scrape these off, care being taken not to injure the insulation. As a final cleaning process, the parts should be washed with gasoline or carbon-tetrachloride. The latter is a solvent of rubber and should not be used on any part where rubber insulation is used, such as on the leads coming into the motor.

For the larger parts the gasoline can be applied with a scrubbing brush or a paint brush. To get into the small spaces between the coils and ventilating ducts, smaller brushes will have to be used. When gasoline is used, the motor should be given an opportunity to dry out thoroughly before putting it into service, and either one of the solvents should be applied where there is a free circulation of air. Although carbon-tetrachloride is non-combustible, it is an anesthetic and is likely to render the one inhaling the gas unconscious.

The Potential Efficiency of Prime Movers

By C. V. KERR
Consulting Engineer, Los Angeles, California

JUST to clear the ground for this discussion, I want to group a few definitions. Work is done by pushing a resistance through space. One can push hard against a stone wall without doing work. The unit of work for the present purpose is the foot-pound; that is, one pound raised one foot. Power is the rate at which work is done; 550 ft.-lb. of work means but little unless that amount of work is to be done in one second, when it becomes one horsepower. Energy is the capacity for doing work.

The nozzle of a Pelton wheel or of a steam turbine provides kinetic energy of jet, which is converted by the machine into brake horsepower. A waterwheel converts into power the potential energy of a body of water that may be lowered a certain height; and the potential efficiency of the wheel may be defined as the ratio of work done to the energy of position of the water used.

If steam expands from high pressure and perhaps superheat (without receiving additional heat) to the atmosphere or into vacuum, the expansion is said to be adiabatic and a certain amount of the heat energy in the steam is made available for conversion into work. This energy is measured in British thermal units, or B.t.u., each of which is the heat required to raise the temperature of one pound of water one degree.

The total heat above 32 deg. in a pound of steam at 200 lb. gage and 100 deg. superheat is 1,259 B.t.u. By adiabatic expansion to atmosphere, 205 B.t.u. are made available for conversion into work. This available heat is the limit of what any engine can convert with the steam supplied, and exhausting at the given pressure.

A hydraulic power plant may be located 800 ft. above sea level and receive water from the 1,000-ft. level, but no one would think of charging the waterwheels in that plant with the energy in the water down to sea level, although someone might ask the designer why he did not locate the plant at a lower level. Just as the fall of water renders energy available for conversion into work by the waterwheel, so this heat fall, by expansion, makes heat energy available for conversion into work by the steam engine or steam turbine; and the potential efficiency of the engine or turbine may be defined as the ratio of heat actually converted into mechanical work to heat available.

As it is impossible for more than the available energy to be converted by any machine, the potential efficiency becomes a fair measure of performance. Some illustrative examples follow:

ONE ordinarily thinks of steam prime movers as being very inefficient in comparison with water turbines. Yet if the input of the water turbine were taken as the total energy in the water measured above sea level, its efficiency would frequently be very low. For a fair comparison, says Mr. Kerr, the efficiency of steam turbines should be figured on the basis of the available energy in the steam over the given range from throttle to exhaust. On this basis the steam engine and turbine make a fairly good showing.

On pages 608-10 of *Power* for Oct. 20, 1925, are description of setting and test data for a 20,000-hp. water turbine. At 85 per cent of gate opening the turbine uses 3,000 cu.ft. of water per second under a net head of 54 ft. and develops 17,000 hp. Then the potential efficiency is

$$P = \frac{550 \times 17{,}000}{62.3 \times 3{,}000 \times 54} = 0.925, \textit{ or } 92.5 \textit{ per cent}$$

In this 550 is foot-pounds per second for one horsepower and 62.3 is weight in pounds of one cubic foot of water.

Again, a certain Pelton wheel working under 1,919-ft. head developed 1,023 hp. at 430 r.p.m. with 5.444 cu.ft. of water per second. Here the potential efficiency works out to be 86.2 per cent. The designers of those wheels may be allowed to "point with pride" to such performances.

Some years ago a small four-stage steam turbine with two disks per stage, designed and tested by the writer, developed 23 brake horsepower at 3,000 r.p.m. with 80 lb. steam pressure and atmospheric back pressure. The actual steam rate was 50 lb. per brake horsepower-hour. The steam was very wet after coming several hundred feet under ground and through a poor separator. With the available heat at 125 B.t.u., as measured on a total-heat-entropy diagram, the potential efficiency is

$$P = \frac{2{,}545}{125 \times 50} = 0.407, \textit{ or } 40.7 \textit{ per cent}$$

In this 2,545 is the heat equivalent, in B.t.u., of a horsepower-hour. If the turbine were 100 per cent efficient, the water rate would be 20.4 lb. instead of 50. But suppose we draw the boiler and coal pile into this discussion, since they are elements in the steam complex. Allow the coal 13,000 B.t.u. per lb. with an actual evaporation per pound of coal of 8.5 lb. from feed water at 200 deg. The coal per brake horsepower-hour is then $50 \div 8.5 = 5.9$ lb.

As we charged the waterwheel with the whole energy between levels, the turbine-boiler power-generating unit with auxiliaries may be charged with the total heat in the coal used. Then the potential efficiency of the steam unit becomes

$$P = \frac{2{,}545}{5.9 \times 13{,}000} = 0.033, \textit{ or } 3.3 \textit{ per cent}$$

which seems disgracefully low, although the little turbine turned 40 per cent of the available heat into brake horsepower.

Some interesting data for the present purpose are found in the efficiency test of a 15,000-kw. turbo-generator reported by *Power* under date of Jan. 27,

1925. At maximum load of 16,286 kw.-hr., or about 8 per cent overload, with steam pressure, at throttle and inlet of 255 and 243.5 lb. gage, and 213.5 deg. superheat at throttle, the water rate was 10.43 lb. per kw.-hr. (29.4-in. vacuum). Then the potential efficiency figures 79.6 per cent.

A systematic and painstaking test on a boiler unit connected to this 15,000-kw. turbine is reported in *Power* for Sept. 16, 1924. With West Virginia nut and slack carrying about 13,300 B.t.u. per lb. as fired, the over-all efficiency was 80 per cent. This corresponds to a coal consumption of 1.12 lb. per kw.hr. at the most economical load on the turbine with a potential efficiency from current to coal of 22.9 per cent.

But what is the steam engine doing? In *Power* for Nov. 3, 1925, on page 696, a curve is reproduced from a test on a 300-hp. unaflow engine supplied with saturated steam at 155.5 lb. gage pressure and exhausting to atmosphere. At the most economical load of 275 to 250 hp., the water rate was 17.6 per i.hp.-hr. Here the potential efficiency for the cylinder alone is 82.7 per cent.

There is also the Diesel oil engine—that aggressive young giant among the internal-combusion engines. Data from a well-known builder of such engines show that a brake horsepower-hour is obtained, as an average at three-quarter load, from 0.42 lb. of fuel oil containing 18,500 B.t.u. per lb. Here the potential efficiency from power to fuel is 32.8 per cent.

If the engine drives a generator having an efficiency of 96 per cent, the potential efficiency from current to oil becomes 31.5 per cent, and the oil consumption per kilowatt-hour, 0.585 lb.

Now comes the interesting question of cost of current in terms of fuel. With coal at $4 per ton of 2,000 lb., the cost of 1,000 kw.-hr. for the 15,000-kw. steam plant at best load will be $2.24. If the oil engine produces a kilowatt-hour on 0.585 lb. of fuel oil or crude oil weighing 7.5 lb. per gal. and costing $1.50 per bbl. of 42 gal., the cost of 1,000 kw.-hr. will be $2.79.

Evidently, much depends on the cost of fuel used, and the ultimate cost is obtained only by adding labor and capital charges due to local conditions. Moreover, some more economical form of prime mover may yet be developed. For example, there is the powdered-coal engine noticed editorially in *Power* for Nov. 3, 1925.

Correcting Reversed Polarity of Direct-Current Generators

By George F. Nussor

When two compound-wound generators are operated in parallel, as in Fig. 1, the no-load voltage of each should be exactly the same. Should the voltage of one generator drop below that of the other, the latter will feed back into the former, tending to run it as a motor. The series winding of the machine running as a motor is reversed to a polarity opposite to what it was when running as a generator, as indicated on machine *B*, Fig. 2. The reversed series field tends to establish a polarity on the field poles opposite to that of the shunt winding. Thus the reversed field of the series winding is bucking the original correct field set up in the shunt winding. This action results in a greatly increased current through the series winding and armature of the machine. The field set up by the increased current in the series winding overcomes that of the shunt winding and reverses the polarity of the field poles. This reversal occurs very quickly and is accompanied by violent sparking on the commutator, and flash overs. The machine, if part of a motor-generator set, may reach an abnormally high speed, and unless it is immediately disconnected from its direct-current busbars it will race and may be wrecked.

To prevent this trouble, the no-load voltage of the generators operating in parallel must be equal. The

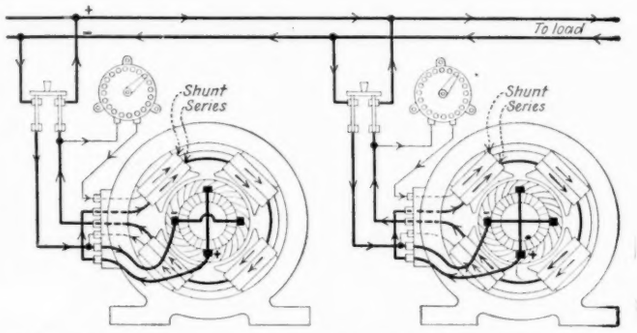


Fig. 1—Two compound-wound generators connected in parallel

machines should be adjusted until this is accomplished. In the event that a generator has reversed its polarity and is disconnected from the busbars, the following is the procedure to re-establish the correct polarity:

If the generator is equipped with a direct-current starting switch, as is often used with motor-generator sets in street-railway plants, start the generator as a shunt-wound motor instead of starting from the alternating-current side, first closing the shunt switch, shunting out the series winding, then start the generator as a shunt-wound motor and the polarity of the shunt winding will come up correct. If the generator is not equipped as stated, then with the machine

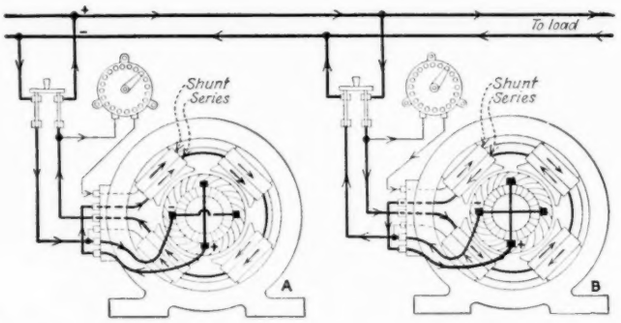


Fig. 2—Same as Fig. 1, except machine B is operating as a motor

standing still, remove all the positive or all the negative brushes and with all resistance cut into the shunt winding, close the direct-current breaker and main switch. Next open the main switch slowly so as to allow the arc to die out gradually. This is important, for it prevents a high voltage being generated with a possibility of puncturing the field windings. If it is not desirable to lift the brushes, either positive or negative armature lead may be disconnected and the field coils energized as previously suggested, or the terminals of the shunt field coils may be disconnected and energized by connecting to the direct-current source, but the two previous methods are advised when convenient.

An Extraordinary Plant

TECHNICAL advances in power generation continue with such rapidity that the sense of wonder is dulled. What would the engineer of only ten years ago say if one could take him by the hand and lead him into a plant where *fireless* boilers supplied steam at 1,700 pounds pressure and 900 degrees F. to an 18,000-kilowatt turbine?

Yet such a plant is no longer a dream. The turbine was ordered last summer for a mine-power station of the Witkowitz Coal Mines in Czechoslovakia, and was briefly described in a news item in the June 2, 1925, issue. Doctor Havliceck, head of the technical department of that company, has just written giving some additional information which appears as a news item in this issue.

Interesting as is the turbine, the steam-generating plant is perhaps even more so. The "boiler"—applying this term to the simple drum unit where evaporation takes place—is not set over a furnace. It receives no heat directly from combustion gases or by radiation from fuel bed or furnace walls. Steam is generated by steam; that is, highly superheated steam from a separately fired superheater is bubbled up through the water in the drum, thereby giving up its superheat to produce additional steam. Steam is pumped in a circuit through superheater to generator and back to superheater.

The steam required for outside use is tapped from the circuit just beyond the superheater. A more detailed description of this process, which was invented by Doctor Löeffler, of Charlottenburg, Germany, may be found in the December 29, 1925, issue of *Power*, along with the report of successful operation of a demonstration plant of this type.

The completion and starting up of the new station will awaited with much interest by engineers all over the world.

Conserving Our Oil Supply

THE recent public hearings before the President's Oil Board developed considerable divergence of opinion among experts as to how rapidly the nation is approaching exhaustion of its oil supply. Oil company officials were, in general, inclined to a more optimistic view than the engineers. The period varied from a minimum of eight years, at the present rate of consumption, as expressed by one expert, to a generation as forecast by another. Such lack of agreement is indicative of the number of factors entering into the problem, the control of which individually and collectively will determine the answer. It was in developing these factors that the hearing served a useful purpose.

Inability to co-ordinate supply and demand, because of diversified ownership of oil lands and present methods of recovery, makes waste inevitable and the cost of production relatively high. It is estimated that less than twenty-five per cent of the oil in fields now under production is brought to the surface. To what extent the remainder may be recovered from the sands depends upon improved methods of the future. This is one of the problems being given careful study. Moreover, five per cent of the wells now produce one-half of the total yield.

The production of crude oil from American wells in 1925 exceeded that of 1924 by seven per cent, and the output of gasoline showed an increase of over twenty-one per cent. The tremendous demand created by the automobile is being met by greater extraction of gasoline from the crude, by blending with benzol and other products, and by improved methods of carburetion. Still greater efforts will continue in this direction, but with increased extraction of gasoline the proportion of other products from the crude must decrease. Promise of settled conditions in the anthracite industry for the next five years is likely to be reflected in decreased demand for domestic furnaces, and there has already been a noticeable reaction as concerns steam boilers for stationary power plants. For marine use the demand will continue, but there is a marked tendency toward its more efficient use in this field.

Byproduct recovery from coal is now receiving considerable attention and is likely to provide some relief in the course of a few years. Shale oil seems farther off, because of the relatively high cost of production.

The government is, of course, concerned primarily with the assurance of an adequate supply of fuel oil for naval purposes and gasoline for aviation. Any action on its part, other than the creation of additional reserves for the purposes of national defense, is likely to be most productive of results if directed toward co-operation with the oil industry in research and along economic lines rather than the adoption of restrictive measures. The report of the President's Board will be awaited with interest.

Expositions

THE progress of industry and the arts has been exemplified by, and written into, the records of many great expositions.

Often, in tracing the development of an invention, reference is made to its initial appearance at one of the London or Paris Expositions, at our own Centennial or World's Fair.

And placing ourselves in the position of a visitor upon one of these occasions, we realize the opportunity afforded to a trained observer of vision and imagination to look through the loopholes that the novel ideas there presented afforded into the future and to forecast what we have seen develop in the interim.

But, like many a good thing, the exposition has been

overdone. Instead of being a spontaneous offering of the accomplishments of the nations to mark the epochs in one another's growth and display the progress of their artistry and craftsmanship, it became a subject of exploitation for mercenary ends. Promoters searched their school histories for something the anniversary of which could be made the excuse for another show. The popcorn and peanut concessions ran into sums of five figures. Exhibitors lost faith in, and the public got out of patience with, them.

More recent practice has been in the direction of local expositions or "shows" of different varieties—dog shows, horse shows, poultry shows, flower shows, automobile shows, chemical shows, electrical shows, power shows—most of these frankly commercial projects, operated for profit to their promoters. They are often held in connection with or simultaneously with the meetings of national or local societies in their respective fields. Sometimes they are adjuncts to such meetings or conventions, and their excess revenue constitutes a collective contribution by the exhibitors to the entertainment features of the occasion.

Whether these exhibitions be actuated by pride of production, philanthropy, publicity seeking, a bid for good will, or simple profit-making, there can be no question of their desirability so long as they are worth while to the exhibitors, but they are waxing so numerous that those who pay for the space and furnish the attractions that make the shows possible are seriously contemplating restricting their participation to a limited number of shows per year.

The annual New York Power Show has been a success from the start and increasingly so year by year. The power show held in connection with the Midwest Power Conference recently in Chicago excelled in number and interest of exhibits the first New York show. Exhibitors at each are pleased and satisfied, but many of them question the necessity of playing to the same audience as often as once a year. There seems to be a decided set in the drift of exhibitor opinion toward making these exhibitions biennial, as has been done with the chemical show, and discouraging increase in the number of enterprises of this kind.

Use the Consulting Engineer

WHEN the owner of an industrial power plant believes that his plant is not as good as it should be, what shall he do about it? Of course his first step will be to talk with those about him who understand power-plant design and operation, beginning with his own operating chief engineer. But then what? The operating chief will naturally be under suspicion if he advises that the old plant be continued, with or without changes. It can be argued that he is biased in his advice by the natural desire to hold his job. To make matters more serious, it may be that the operating chief is pitted against trained salesmen for central-station power. His limited experience in both engineering and argument may render him incapable of sustaining his contentions.

The owner, on the other hand, is far from assured that the arguments put before him are entirely sound. Each side has an ax to grind, and he is sure to hold the bag, whatever the outcome. He is intensely interested in having the right answer.

Right here is where the consulting engineer should be called in. He knows the issues involved, and his wide familiarity with the entire field of power and heat generation and utilization, with all the modern complexities in plant design, puts him in a position to suggest possibilities of which the operating man may never have heard. His sole interest should be to give his client the necessary power and heat at the lowest over-all net cost.

When a man is ill, he consults an expert—a reputable physician in whom he has confidence and whose only desire is to advise his patient for his own well-being. When his power plant is ailing, his sensible course is the same, to consult a trustworthy expert whose bread and butter depends upon his giving the right answer from the owner's point of view, and who holds no special brief for either the isolated plant or the central station.

Further, it is wise for any man to consult his physician periodically, even when he feels well, for a searching examination to determine any possible signs of approaching trouble. Likewise, it is good business to call in the consulting engineer for an occasional study of the small power plant, to discover possible shortcomings in equipment and operating methods. In many cases he will be able to recommend changes that will result in marked savings in cost. It is not wise to wait until trouble has appeared. It is far easier to see clearly and to think dispassionately under clear skies. Many wrong decisions have been made under the stress of storm.

The operating man should welcome the consulting engineer as his friend, who will study his methods and advise changes in method or equipment leading to better and more economical operation. The central station will recognize in him a man whose opinion is based on sound engineering and common sense and whose advice will be uninfluenced by fear or favor. Above all, the owner will find in him a staunch supporter in the continuing strife for lower costs in his enterprise. If he advises changes, the resulting savings will speedily wipe out his fee. If he advises no change, his fee is a small price to pay for the feeling of satisfaction.

Lessening the Gap

THE Philadelphia Engineers Club has had the courage to take up a subject that some of our National engineering societies have at times soft-pedaled because of its possible controversial nature. If attendance be a criterion, the all-day session on "Purchased Versus Privately Generated Power" at the Club last week would indicate that this is a subject of keen interest to a large body of engineers.

Instead of being productive of animosities, the meeting was most harmonious and brought out much constructive thinking in which both the private plant and central station service were accorded their legitimate places. The problem is one admitting of no general conclusions, but requires definite analysis along engineering lines in each individual case, the key to the situation being the use of process steam.

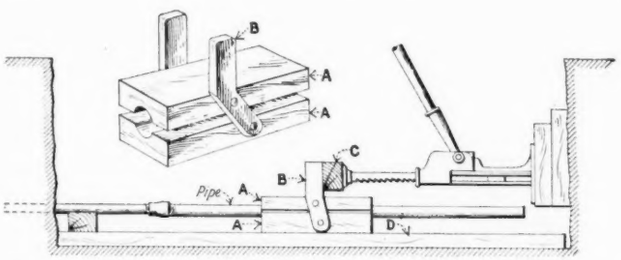
The suggestion advanced by some of the speakers for greater co-operation between large industrial plants and central stations, in the way of interchange of power under proper safeguards, met with apparent approval.

The Philadelphia Engineers Club is to be congratulated on the success of its meeting. Now that it has set the precedent, perhaps some of the other societies may be less fearful.

Practical Ideas From Practical Men

Method Used in Forcing Pipe Through Ground Under Pavement

In laying a 2-in. pipe from our boiler room to a pump across the street, we used the mole method by digging an opening to the depth of the position of the pipe on each side of the street and pushing the pipe through. This was accomplished by first using a 3-in. pipe for a distance of 10 ft. then removing and pushing



Detail of clamp used to grip pipe and how it was used

a 2½-in. one for 15 ft. then removing and pushing the 2-in. the balance of the 45 ft. necessary to reach the hole on the opposite side.

A 10-ton lever jack was used to give the necessary pressure and the ground being soft, the work was accomplished with ease and good accuracy, the opposite end entering the opening at but 8 in. from the position aimed at when starting.

The speed of the work was due to a clamp we made for gripping the pipe. Two hickory blocks each 16 in. long and 6 in. square, were grooved out so as to fit the 3-in. pipe, and two levers as shown at *B* were forged. These were pivoted to the blocks as shown, and bolted solid to another block. A 3-in. plank *D* was first leveled in the bottom of the pit and the bottom one of the clamp blocks *A* and the end of the pipe were then leveled on this plank.

The action of the clamp, as may be seen, is automatic. When the pressure from the jack is applied to the two arms, these force the two blocks together, gripping the pipe sufficiently to prevent slipping. When the smaller sizes were used, pieces of the next two larger sizes were split in halves and used for bushings between the 2-in. pipe and the clamp. When the two larger sizes had been pushed the required distance, the jack and clamp were reversed—that is, set to the opposite side of the bank—and the lengths of pipe pushed out in the same manner as they had been pushed in. The ends of the two larger pipes were left open and allowed to cut through the soil, but the smaller one was fitted with a point and forced to open the hole in which it remained after being pushed through. Putting the pipe through in this way saved the tearing up of the pavement as well as the excavation of about 20 yd. of earth, as well as the replacement of this material.

North Bend, Ind. G. G. McVICKER.

Handwheel Wrench for Use in Opening and Closing Valves

Some time ago there was illustrated in *Power* a wrench for use on the handwheels of valves when closing or opening them. As the type of wrench shown required considerable work in the making, it occurred to me that a description of the wrench we use might be of interest.

As there are usually some scraps of round iron around a plant, we take a piece of suitable size and length, depending upon the size of valve the wrench is to be used with, and first heat it red hot in the furnace, then bend it around a ¾-in. rod or pipe to form a handle. We next put the open end in the vise and twist it a few turns, then bend the two ends at right angles to form short prongs to fit over the arms of the handwheel. Of course it is necessary to heat it several times while doing this.

With a wrench of this kind one man can often close or open a large valve without assistance, whereas without it two men would be required. L. E. ANDERSON.

Pittsburgh, Pa.

Overcoming Foundation Vibration Troubles

The figure shows an arrangement that I have never seen published, and it may prove of interest and help to engineers that are having the same trouble that we had. We have two four-cylinder Diesel engines driving

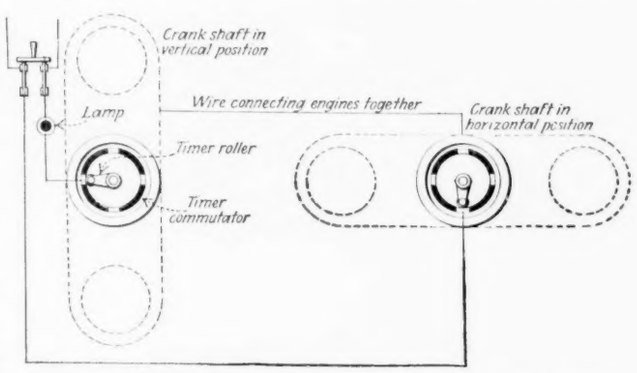


Diagram showing how the timers were connected

alternating-current generators running in parallel. As the soil at this place is poor for foundations, there was trouble with considerable vibration, and as our plant is near one of the finest residences in the city, the matter became serious. To overcome the difficulty, a method to break-step the shafts of the engines was devised which has proved successful.

First, there was mounted on the end of each crankshaft a Ford timer roller. Next, the timer commutator was fastened rigidly to the frame of the engine, using

only one of the four contacts and timing them so that when one shaft was in the vertical plane, it would make contact and the other timed to make contact when in the horizontal plane, as in the figure. These were connected as shown to a direct-current supply, through a switch and lamp. Direct-current was used so as to avoid grounds from the alternating-current circuits, and a 60-volt lamp was used because the flash from a 110-volt lamp was too slow to give the correct time to close the switch before the engines would be slightly out of step.

Our method of putting the two engines together is to have the incoming engine running a little fast as shown by the synchronoscope, then wait for the shafts to come in a position to cause the lamp to flash, when the switch is closed. Closing the switch will hold the rotors of the two machines in the same relative position as long as they are both running on the line.

Caruthersville, Mo. GEORGE A. HIGGINS.

Savings Possible Through the Proper Utilization of Water in Industrial Plants

Efficient utilization of water is an important item in many industrial plants in or near large commercial centers, where water is billed at metered rates varying all the way from $0.75 to $1.15 per 1,000 cu.ft., and a brief study of each phase of water consumption often discloses possibilities for savings.

This may be illustrated by the experience of an engineer who made a survey of the various sources of water consumption on a system that had been in service for a number of years.

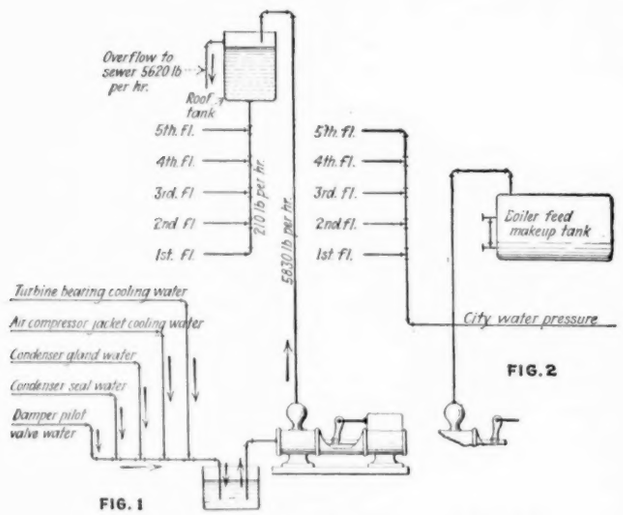


Diagram of water piping before and after making change

Bearing cooling water of a turbine, condenser gland and sealing water, air-compressor cooling water, and various other pure water, drains were piped to a sump from where they were pumped to a tank on the roof to supply the water for flushing toilets. This tank had a 2-in. overflow pipe that ran down the side of the building partly concealed, to a roof leader and thence to the sewer.

Upon observation over a period of days it was discovered that water was continually flowing through the overflow pipe into the sewer during the operation of the plant, making it at once apparent that the flushing water demand was less than the volume of water pumped to the tank, thereby disclosing a hitherto unnoticed waste of fresh water.

In order to determine the amount of water being pumped and the amount overflowing, a 53-gal. drum was used to measure the water before it entered the sump and a similar one to measure the overflow of the roof tank. By noting the time required to fill each tank, we were able to determine the normal flushing water demand.

The amount of boiler-feed makeup water in this particular plant averaged approximately 6,100 lb. per hour and was taken from the city mains and introduced into the feed makeup tank through an automatic float and regulating valve.

With the tests completed and results checked, it was found that the water pumped to the roof tank amounted to 5,830 lb. per hour, the water going to the sewer 5,620 lb. per hour and the normal flushing-water consumption only 210 lb. per hour.

By rearranging the system as shown in Fig. 2, which included the connecting of the automatic flush valves to the city water pressure, and pumping the cooling, sealing and jacket water directly into the boiler-feed makeup tank, a saving of 5,830 — 210, or 5,620 lb. per hour was made, which at the cost of $0.90 per 1,000 cu.ft. and 10 hours per day showed a saving of $250 per year as well as eliminating the use of the roof tank.

various other pure water drains were piped to a sump

The foregoing is a good example of the small wastes that may be going on in many plants. The saving may be comparatively small but it does not cost very much to obtain and makes it well worth while going after.

Jersey City, N. J. E. A. BAERER.

Pure Water from Exhaust Steam

Exhaust steam contains cylinder oil, iron oxide from the pipes through which it passes and other impurities. Oils are highly complex hydrocarbons. Although most of the heavier fractions are removed by the grease extractor and traps, the lighter oils persist. It is therefore better to take the steam to be condensed from a main through which it is flowing at a considerable distance from the engine. This is because in its progress through the pipes, the steam is continually rolling over the inner surface from the center of the pipe outwardly and gradually depositing oil and other impurities. Much of these impurities is laved off the walls of the pipe by the condensation and carried along the pipe with the steam.

Steam has a great affinity for iron, so that a section of brass or copper pipe several feet long should be a part of the main from which the steam is to be drawn. This section of pipe, if horizontal, should be tapped or have a tee opening on the under side near its discharge end. Through this opening should be screwed a brass nipple terminating in the axial center of the pipe. If the steam is carried from this nipple through brass piping and fittings to any condenser, it will condense into pure water. The reason the nipple should extend upward to the center of the main is because there only is the steam pure. Also because any condensation will find its way to the bottom of the main and be carried past the nipple by the steam.

Elgin, Ill. P. L. WATERS.

Comments from Readers

Shall the Symbol Be M or K?

I have read with interest Louis Elliott's letter in the Feb. 16 issue recommending the use of the symbol M.B.t.u. for 1,000 B.t.u.'s, for which the name unit of evaporation has been proposed. I should like to add a thought to Mr. Elliott's recommendation, which it seems to me would bring it more in line with existing practice in the power field.

The symbol M is used widely in mercantile enterprises to designate 1,000, this usage coming from the use of the letter M in the Roman system of notation to designate 1,000. In the power field, on the other hand, the symbol K has long been generally used as an abbreviation of the syllable kilo, which is derived from the Greek word meaning 1,000. Thus we have kilovolts and kilowatts, abbreviated, of course, kv. and kw. Would it not be well, since we are in a closely related field, to employ the same symbol, calling 1,000 heat units K.B.t.u.?

One further thought. In a number of large operating companies it has become desirable to have a larger unit of power than the kilowatt, and in many places the megawatt is in constant use, designating 1,000,000 watts, or 1,000 kw. This is obviously abbreviated Mw., and both the name and the abbreviation have proved both satisfactory and convenient. The term megohm is in common use. The syllable mega comes from the Greek word meaning great.

By analogy with this practice it seems to me that we should retain the symbol M.B.t.u. to designate 1,000,000 B.t.u.'s, should it ever seem desirable to use such a large unit.

It is unfortunate that the name of our heat unit comprises three distinct words. If it were a single word, such as "therm," as has been suggested, it would then be possible to use the words kilotherm and megatherm, and the abbreviations KTh. and MTh. Or perhaps Kθ and Mθ. The use of the letter θ as an abbreviation for the word therm would serve to distinguish it effectively from the use of the letter T which stands for temperature.

JAMES A. HARRIS.

New York City.

The Use of Fuel Oil as Fuel

The report of the meeting of the Affiliated Technical Societies of Boston in the Dec. 22, 1925 issue, makes it appear that I stated that "the use of oil for fuel should be discouraged." That is not my opinion. It may be the view of your correspondent.

I pointed out that the cracking process had created a new phase in the history of oil and it was now more or less of a battle between oil as fuel for power purposes and oil for cracking to meet the increasing demand for gasoline. I showed that nevertheless more than one-half of the total crude oil brought out of the ground is used for fuel purposes. This condition has existed for years and is likely to continue for some time to come. This means an annual supply of oil fuel now approximating 400 million barrels. All this oil is burned for fuel, and it is an ideal fuel.

There exists in certain quarters a feeling that it is an economic crime to use oil for fuel. That is not my view and I consider it untenable. It is based on the thought that a natural product that yields lubricants, dyes, medicines, cosmetics and hundreds of other more or less useful substances should not be "burned up," even if by so doing an economical, labor-saving, smokeless fuel is utilized, the use of which tends to reduce the general cost of living.

I would remind those who hold this opinion about fuel oil, that coal also produces lubricants, dyes, medicines and cosmetics and hundreds of other more or less useful things; in fact, coal will even produce oil itself. It might be contended with equal force that the use of coal as fuel is an economic crime.

But what about gasoline? Is it not an economic crime to use this precious liquid in the way that thousands and thousands of barrels are being used today? For example, take the high-powered gasoline racing machines. Take the expensive limousines of ten and eleven feet wheel base, that occupy the space and burn more "gas" than four or five of the smaller cars. Take the enormous, heavy and extremely uneconomical motor trucks that crowd the highways at the expense of the taxpayers and that are squeezing the railroads to death. This is economic waste, and waste is akin to crime.

I admit that a great deal of fuel oil is wasted by uneconomic methods of burning, and I'll agree to call this economic crime. But not so when this ideal fuel is properly and efficiently handled.

New York City. E. H. PEABODY.

The Hydrostatic Test for Boilers

Referring to the article by George M. Jacobs, in the Jan. 19 issue with reference to "Hydrostatic Test for Boilers," I wish to make the following reply:

I partly agree with the opinions expressed by Arthur Jones in the Dec. 8, 1925, issue that a hydrostatic test is no good unless it is followed by a thorough internal and external inspection and a hammer test.

During the year 1919 I was requested to make a test of a vertical submerged tubular boiler which was used in connection with the laundry in a city hospital. The boiler was located under the main ward. After taking the matter up with the engineer, he requested that a hydrostatic test be made. The boiler was filled with water, the safety valve removed and the opening plugged. The boiler was operated at a pressure of 80 lb. and a hydrostatic pressure of 120 lb. was applied. This pressure was held on the boiler for about ten minutes, and as no leakage or distress developed, the water was drawn off the boiler and the handhole plates removed. I then made a hammer test and found the firebox lower tube sheet and outside shell in perfect condition. When applying the hammer test to the cone of the boiler the sound convinced me that the plate was

defective. I decided to give it a thorough test and in doing so the pean of the hammer went through the plate in two places, where the metal was corroded away to a thickness of $\frac{1}{32}$ inch.

If the hammer test had not been applied, and the boiler had been allowed to operate on the assumption that it was safe to do so because a hydrostatic test had been applied, it would have been only a question of time, as to how long the boiler would operate before blowing up with probable disastrous and fatal results.

With reference to the recent explosion of the boiler on the steamer "Mackinac," it was reported that a hydrostatic test had been applied to the boiler. If this test had been followed by a thorough internal and external inspection and a hammer test had been made, especially to the circulating tube, I cannot understand why the reported defects were not discovered.

I dare say there are some inspectors who rely wholly on the hydrostatic test without making a thorough internal and external inspection or hammer test of the boiler. It is only through an act of Divine Providence that there is not a greater loss of life and destruction of property due to the use of defective boilers and improper inspection.

Mr. Jacobs calls attention in his article to a boiler 38 years old on which a pressure of 60 lb. was allowed on the last inspection. As he does not give the diameter of the boiler or the pitch of the rivets, I cannot determine how much pressure would be allowed if a factor of safety of seven were used.

Albany, N. Y. SAMUEL A. BOWEN, Inspector,
N. Y. State Labor Department.

Engineering and the Man

Referring to the comments on "Engineering and the Man," by Robert H. Emerick in the Sept. 8, 1925, issue and also by E. Ogur in the Jan. 5 issue much has been said, much more can be said, and it is hoped that the whole discussion will aid the engineer and the man to see his position clearly and to sell himself and his profession at their true value.

There is another angle from which the engineer, the man, the college graduate and the student engineer should see their position of worldly service and thus collect their just recompense. Engineering training at the university develops the analytical mind of the student as no other course of study in the college's curriculum could. The nearest approach to this analytical mind training in other of the academic courses is that given in courses of logic and psychology, and these courses are mild in their results along this line as compared to the sequence of thought training which engineering gives.

It follows then, that for those students or graduate engineers whose minds have become corrupted with regard to the profession and its practical possibilities as an income producer of consequence—that 80 per cent, of which Mr. Ogur speaks, who seek positions in the business world outside of engineering because of economic conditions—there is that vast opportunity for the engineer in business and for the engineer in government which the engineer should foresee through his logically trained mind.

That portion of President Coolidge's speech wherein he said ". . . more business in government," throws governmental possibilities directly at the engineer. The engineer truly belongs at the head of municipal and state, as well as national government and he is already coming well to the front in municipalities as city manager.

Fertile fields for the graduate engineer also exist in the business world as an employee, and it is the engineering trained man whose head will rise above those of the masses.

If the professors and the engineering fraternity in general will point out and impress these ideas and visualize the possibilities of the engineer in business to their apprentices, the graduate engineer and future business men, the student will leave his college full of that pep and enthusiasm which Mr. Ogur tells us is lacking today. And in the future tomorrow's business man will realize that he must prepare himself through a course in engineering to obtain that broad viewpoint and analytical mind, that quality of fairness, that spirit which has made this country great in the eyes of the world because of the constructive purpose of its people. The business world will look up to the engineering fraternity, as a whole, and incidentally the income of its members will enhance to a true value.

Oakland, Calif. S. H. SAMUELS.

Burning Low-Grade Coal

With reference to the article in the Dec. 8, 1925, issue by Andrew F. Sheehan on the burning of low-grade coal, I should like to add a word of comment regarding the burning of the hydrogen that is contained in coal or oil.

Mr. Sheehan says that he changed from a coal costing $8.10 per ton to one costing only $7, the lower-grade being higher in hydrogen content, which he considered an advantage since the combustion of one pound of hydrogen produces 62,500 B.t.u.

I have always understood that the hydrogen content of any fuel is a detriment rather than an advantage due to the fact that the hydrogen unites with the oxygen furnished for combustion, the resulting product being H_2O, or water, which exists in the furnace as highly superheated steam.

Now if it were possible to condense this steam before it left the heating surface of the boiler so that the heat that it contained could be given up to the water contained in the boiler, there would be a gain in available heat from the burning of the hydrogen. However, since the superheated steam resulting from burning the hydrogen is at approximately atmospheric pressure, it would be necessary to cool the steam to 212 deg. or slightly less in order that it might give up its heat. Manifestly, this is impossible in practice.

Furthermore, if the steam condenses at any point in the metal flues, uptake or stack, the resulting water would combine with the sulphur fumes produced from combustion of the sulphur content of the coal to form sulphurous or sulphuric acid which will attack the metal and cause corrosion.

Since the conditions that exist in the analysis of fuel by means of the bomb calorimeter are ideal for the recovery of all the heat resulting from the combustion of hydrogen, it naturally follows that the B.t.u. content as shown by analysis may be misleading when considered from the point of performance in the boiler furnace where the heat resulting from combustion of the hydrogen cannot be reclaimed, but passes out of the stack as a loss.

The magnitude of this loss will be proportional to

the hydrogen content of the fuel, the temperature of the fuel entering the furnace and the temperature of the exit gases, and is expressed by the following formula:

$$\textit{Loss in B.t.u. per lb. of dry fuel} = 9Hy[212 - t + 970.4 + 0.47(T - 212)]$$

in which

Hy = Per cent by weight of hydrogen in dry fuel;
t = Temperature of fuel as fired in degrees F.;
970.4 = Latent heat of steam;
0.47 = Specific heat of superheated steam;
T = Temperature of flue gases in degrees F.

In order to show how great this loss may be with a fuel running high in hydrogen, take for example the burning of a fuel oil having a heat value of 18,600 B.t.u. per lb. and 11 per cent hydrogen, which is the value of a fuel oil with which I am familiar.

Then Hy in the formula will = 0.11
t will be taken at 200 deg. F.
T will be taken at 500 deg. F.

$$\textit{B.t.u. loss} = 0.11 \times 9[212 - 200 + 970.4 + 0.47(500 - 212)] = 1106.58$$

Since the total heat value of the fuel as shown by the calorimeter is 18,600 B.t.u. per lb., the loss in the furnace due to combustion of the hydrogen will be approximately 6 per cent of the heat value of the fuel and the available B.t.u. will be approximately 17,494.

It would have been interesting to see what results would have been obtained by Mr. Sheehan with the higher-grade coal using the same method of firing as was pursued with the cheaper grade.

It has always been my opinion that low-volatile, low-ash but high B.t.u. coal is the cheapest coal for New England industries to burn, as the difference in price paid for the lower grades will be more than offset by increased freight charges, extra bunker space, greater cost of handling coal and ash at the plant and larger grate surface required for the same capacity of boiler plant.

C. B. HUDSON.

North Plymouth, Mass.

Are Welded Pressure Tanks Safe?

I was much interested in the editorial in the Nov. 10, 1925, issue, "Are Welded Pressure Tanks Safe?" The article opens the way for a discussion of this important question, and I should like to add my testimony that an efficient system of testing should be applied to all welded pressure vessels.

Many questions have been raised during the last few years as to the best system and whether autogenous welding should be permitted for high-pressure jobs. It is essential, therefore, to consider the points necessary for safe welding and strive to find the reason why some autogenous welds are not sound and others satisfactory. The subject of modern welding methods, as *Power* columns show, is now receiving the careful investigation that it deserves.

The art of riveting has received careful consideration, and the science has been reduced to the point where the plant engineer can make a definite calculation as to the strength and service of a riveted joint. Why should the engineer not be able to reduce autogenous welding to such a state that he can make calculations with a fair assurance that they are accurate? True, a weld has something of the mysterious and uncontrollable about it that a rivet seam or joint has not, at least in the same degree. In spite of this there is a growing tendency toward the use of welded joints in both steam and unfired pressure vessels, especially in those industries where uniform surfaces and absence of rivet heads are desirable. It therefore behooves the welding industry to see that autogenous welding methods are used without danger, hence the desirability of standardization in the testing of welds.

At the time of writing, I have in front of me the results of two welded joint failures illustrating how little the character of a weld can be revealed by testing, by the fact that in both cases the inspectors allowed themselves to be deceived by the external appearance of the weld.

It is, however, sometimes stated that the soundness of a welded joint cannot be ascertained by an inspector or by any test short of destruction, unless it be by means of the X ray. It would appear therefore that examination by X rays has an important future before it.

The testing of welds, however thoroughly done, can add but little to the safety of the process. For if a weld can be tested to destruction, it is quite easy to ascertain whether it has been a good or a bad one. A mere section cut through it, supplemented by a simple metallographic examination, gives all the data desired, and this may be readily amplified by any number of mechanical tests. Such testing is necessary, but it must, for the sake of safety and reliability, be regarded as subsidiary to two other factors—careful selection of the precise method of welding to be employed and of the individual to be entrusted with the job, and constant and vigilant supervision and inspection. Nowhere can the traces of faulty workmanship be hidden so effectively, although even the most conscientious workman cannot be certain that a weld is entirely sound. Hence, it would appear that the safeguard lies in the hands of the engineer who has to decide whether autogenously welded joints should be employed. It is well known that many engineers do not have much faith in welded joints for high-pressure jobs, but experience has shown that welded joints properly made under the correct conditions prove satisfactory in the construction of pressure tanks.

In order to obtain the best results, it is necessary to have welding operators who thoroughly understand the limitations of autogenous welding and are careful to see that the materials properly fuse together. Welders must also see that the sheets or plates are perfectly clean—free from scale, rust or foreign matter; that they are properly prepared—correct beveling, or the proper distance between sheets is allowed; and that the materials are of the best quality in order to secure satisfactory results.

The great need in autogenous welding—oxyacetylene and electric—is for some standardized method of determining or measuring the relative value of a welded joint. The ideal weld is presumably one in which the joint has the same characteristics as the adjacent areas. If this view be correct, what tests should be made to determine these characteristics, and how is the degree of approximation of weld to the ideal to be determined? My views are, that the "pressure and impact test" is the most reliable test for welded joints in high-pressure vessels; whereby the welded products are subjected to an internal hydrostatic pressure at three times the normal operating pressure in pounds per square inch. While holding this pressure, the welds and adjacent areas are hammered.

E. ANDREWS.

Manchester, England.

Questions and Answers

Conducted by

Franklin Van Winkle

Starting a Centrifugal Pump

Will you please let me know if a centrifugal pump should be started with the discharge valve closed? Also, should it have a check valve? H. C.

A foot valve in the suction line will keep the pump primed. The net area of the foot valve should be at least equal to the area of the suction pipe and preferably larger. When ready to start, fill the pump with water, close the discharge valve and start the pump. When it is up to speed, open the discharge valve gradually until the desired capacity is obtained.

Figure Inside Area of Fire Tubes

An error crept into the answer to a question published on page 112 of the Jan. 19 issue. In computing the heating surface of a horizontal-return-tubular boiler the outside surface was used instead of the inside. This gives a result about 10 per cent too high. It is now standard practice to figure the heating surface on the side in contact with the hot gases, that is, the inside in the case of fire tubes and the outside in the case of water tubes. This standard has been established by the American Boiler Manufacturers Association. It is also contained in the A.S.M.E. Boiler Code.

Operating A. C. Motors in Parallel

Can two alternating-current motors be operated in parallel? We have a squirrel-cage motor operating overloaded and would like to purchase another motor about the same size and connect it in parallel with the one now in use on the same load. M. E. W.

Two motors of any type may be operated on the same load, and quite a number of such installations have been made. For most satisfactory operation the motors should be alike, that is of the same type, size and built by the same manufacturer. They also must be maintained in the same working condition. For example, if the winding on the rotor of one of the squirrel-cage motors was to develop some high-resistance connection between the bars and end rings, this motor would tend to shirk the load. This would also apply to slip-ring type motors; anything that might change the resistance of the rotor, such as poor connections between the rings and brushes or even a difference in the quality of the brushes, might cause a difference in the division of the load between the two motors.

Where wound-rotor motors are used and it is desired to control the speed, it will be necessary to have the two controllers geared together so that they will operate as a single unit. Two wound-rotor motors have been operated from a single controller and resistance, but this requires phasing out the machines and is not so satisfactory as using two separate controllers interlocked to operate simultaneously.

When everything is considered, it will probably be found to be more economical to install a motor large enough to carry the load. This motor will have a higher efficiency than two smaller ones, consequently the power consumption will be less. The maintenance charges will also be lower on a single machine than on two motors of one-half the size. These two factors alone should make the difference in cost a good investment, between a new motor large enough to carry the load and what can be realized on the old motor when sold, plus the cost of the smaller motor if it were installed.

Water Circulation on Hydraulic Elevators

Starting with the suction pipe of the pump, how does the water travel through the system for horizontal and vertical hydraulic elevators? W. H.

On horizontal-cylinder machines, the water is taken from the surge tank, which is an open-top tank, by means of a pump and forced into the pressure tank. The water is taken from here through suitable piping to the elevator controlling valve. This valve admits the water to the cylinder and causes the piston to move outward, and this, in turn, causes the car to ascend through the system of sheaves and cables. The car descends by gravity when the controlling valve port is opened from the cylinder to the discharge line. The piston, forced inward by the weight of the car, shoves the water out of the cylinder through the discharge ports of the main valve and through the discharge pipe to the surge tank.

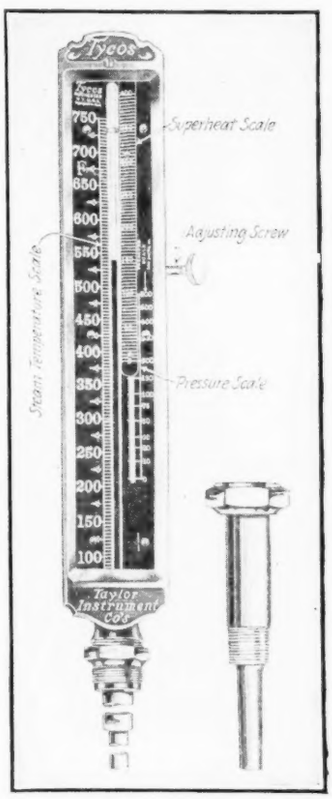
The water is taken from the surge tank on vertical-cylinder machines through the pump to the pressure tank, out of the pressure tank to the controlling valve, through the controlling valve to the circulating pipe and top of the cylinder. In some instances the pressure line connects directly with the circulating pipe without going through the controlling valve. The piston is forced downward in the cylinder, and this, through the system of sheaves and cables, causes the car to ascend. In descending, the controlling valve shuts off the supply of water from the pressure tank to the cylinder, and simultaneously opens a port which, through suitable piping, connects the top of the cylinder with the bottom, and the water circulates from above the piston to the space below the piston in the cylinder as the piston ascends, and while the car is descending. The stopping of the car by the controlling valve is accomplished by closing the port which permits the water to circulate from the top to the bottom of the cylinder. The water leaves the cylinder to go to the surge tank when the car is ascending.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses.—Editor.]

New and Improved Equipment

Tycos Direct-Reading Superheat Indicator

A high-temperature thermometer to which has been added a scale to facilitate the reading of the degree of superheat direct without reference to the steam tables, is a recent development of



High-temperature thermometer with superheat indicator

the Taylor Instrument Companies, Rochester, N. Y.

Referring to the illustration, which shows a standard separable socket thermometer for use on superheated steam lines, an adjustable superheat scale and pressure scale has been placed to the right of the mercury column.

To determine the degree of superheat, the zero of the adjustable superheat scale is moved by means of an adjusting screw, opposite the pressure indicated by the steam gage, which in this case is shown at 200 lb. Then by noting the total steam temperature, as indicated by the mercury column of the thermometer (548 deg.), the degree of superheat (150 deg.) is shown directly opposite this reading on the right-hand scale.

The adjustable superheat scale is moved up and down by means of a track and pinion operated by a knurled nut conveniently placed on the side of the thermometer.

Sturtevant Air Heater

In the report of the Power Show in the Dec. 8, 1925, issue brief mention was made of an air heater recently brought out by the B. F. Sturtevant Co., Hyde Park, Boston, Mass. A front view of the heater and further details of its construction are given herewith.

The heater consists of a series of chambers made by flat plates the edges of which are brought through channel irons on one side and welded to them. The chambers are assembled side by side in a structural-steel frame and clamped in position, having asbestos packing calked between the channels to insure against air leakage.

A feature of the air heater is the provision made for reversing the sections to increase the life of the heater. As the corrosion usually takes place

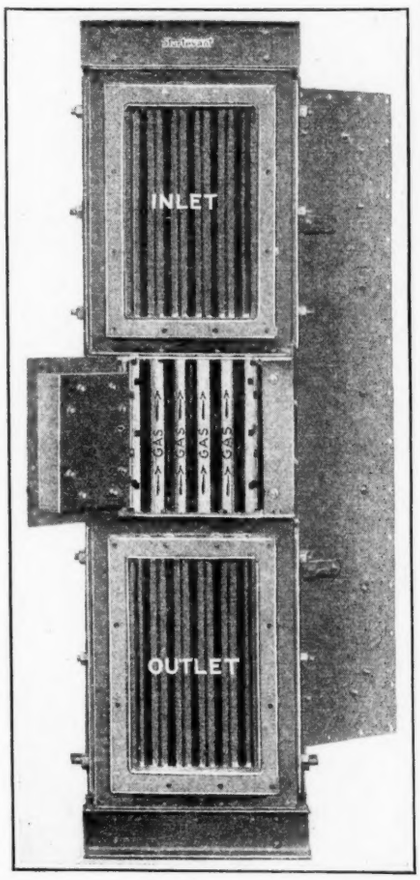


Fig. 1—Front view of heater

on the cold end of the machine, or the end where the gases leave, by turning the sections end for end after a certain period of service, the life of the heater is materially lengthened. The sections are removed from the back of the heater by simply removing the rear cover plate and the spacer bars which lock the plates in position. Removing the rear cover plate also makes the plates accessible for inspection and cleaning. The inlet and outlet for the air is

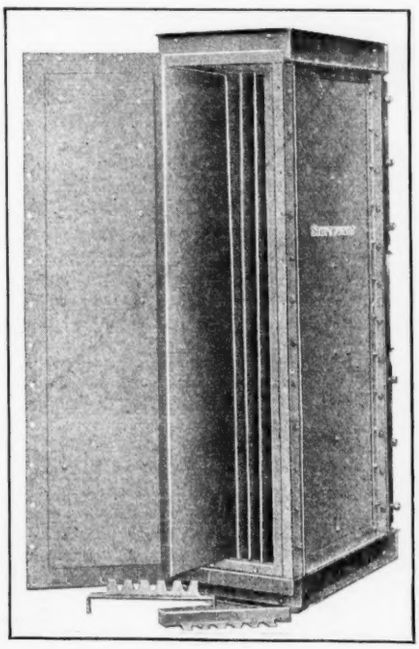


Fig. 2—Rear view showing one section partly removed

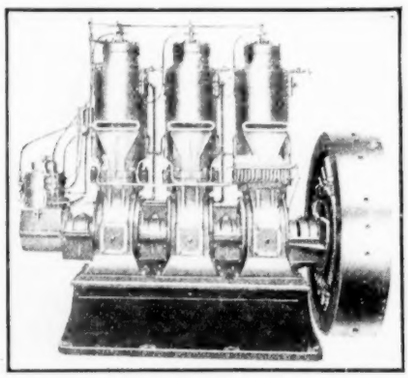
indicated in Fig. 1, while the gas passes between the plates in the opposition direction to that of the air.

Flywheel-Type Alternators for Steam, Gas and Oil Engine Drive

The Ideal Electric & Manufacturing Co., which recently brought out a new line of synchronous motors called the flywheel type, is now in a position to furnish this machine as engine-type alternators. This type of alternator construction creates a self-contained power unit, being an integral part of the engine, as shown. It occupies considerably less space than the conventional design, and does away with the generator foundation and erecting. The stator is supported on the engine bearing, and the field poles are mounted inside the flywheel and are arranged to revolve about the outside of the stator instead of inside as in the conventional design.

With the same rotor weight the flywheel effect of the flywheel-type alternator is nearly twice that of the usual design. If extra-heavy flywheel effect is desired, the rotor construction has a double-rim section. This type of

alternator does not require an auxiliary flywheel, and the problem of incorporating the necessary flywheel effect in the alternator rotor has merely become a question of bearing limitations. An exciter or any auxiliary machine may conveniently be belted to the flywheel rotor, thus saving an auxiliary pulley.



Alternator on the right, forms part of the flywheel

Detroit Double-Retort Side Cleaning Stoker

To meet the demand for a mechanical stoker suitable for a boiler having between 3,000 and 5,000 sq.ft. of heating surface and one having the side cleaning feature to permit installation in a limited space, the Detroit Stoker Co., Detroit, Mich., has brought out the double-retort stoker shown in the illustrations.

A front view is shown in Fig. 1 and an assembly in Fig. 2. The retorts are arranged with a single row of tuyere blocks between them, and from the sides heavy grates are inclined downward toward the side walls. At the ends of these grates dumping plates of the grate-bar type with air ports are located and are arranged for operating from the front of the stoker. A central air chamber is provided below the retorts, and a damper between each ashpit and the air chamber allows air to be admitted to the dump plates as required to burn out the combustible in the ash more completely before dumping.

Independent control is provided for the coal feed to each retort, the stroke of each ram being adjustable from full stroke to no stroke. Provision is also made for adjusting the stroke of the auxiliary pusher bar as well as the rate of flow of the fuel to the dump plate on the side.

One of the advantages claimed for the stoker is its adaptability to existing boiler installations, as no basement or tunnel is necessary for ash removal and little if any excavation or concrete work is required. Referring to the illustrations, it will be seen that doors are provided in the front of the stokers at levels slightly above and also below the dump plates. This permits the ashes and refuse to be removed at the front of the boiler directly onto the boiler-room floor.

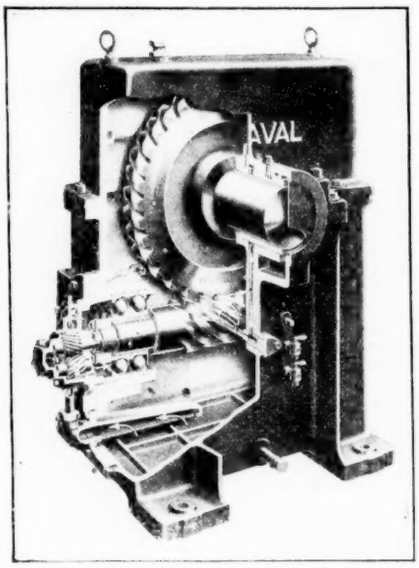
The stoker-driving mechanism and the method employed of distributing the coal are essentially the same as those used on the single- and multiple-retort stokers made by this company.

De Laval Reduction Gears with Pressure Oiling System

The illustration shows a positive oiling system recently developed by the De Laval Steam Turbine Co., Trenton, N. J., for use on reduction gears that operate at high speeds or transmit large powers.

With this oiling system, which consists essentially of a gear pump direct connected from the wormshaft, the worm threads are supplied by a spray of oil and all the bearings receive oil under pressure. The oil is drawn through a bronze strainer located a little above the bottom of the reservoir, by the pump, and discharged through passages in the casings to spray nozzles on both sides of the worm and also to the bearings.

The oil passages are so arranged that they can be cleaned readily, and the spray nozzles can be removed without disturbing piping. The oil pressure is maintained constant by an automatic relief valve irrespective of the speed of the drive. When desirable, an oil cooler can be connected into the system.



Worm reduction gear with pressure oiling system

The world consumption of gasoline has increased remarkably during the last few years. American production has grown from less than 1,500,000,000 gallons in 1914 to over 8,950,000,000 gallons in 1924, an increase of 500 per cent. The 1925 figure is estimated at 10,886,127,000 gals. Our exports of gasoline have risen from 217,750,941 gallons in 1914 to a record figure of 1,219,474,374 gallons in 1924. The stocks of gasoline on hand at the end of 1925 were 1,648,320,000 gallons.

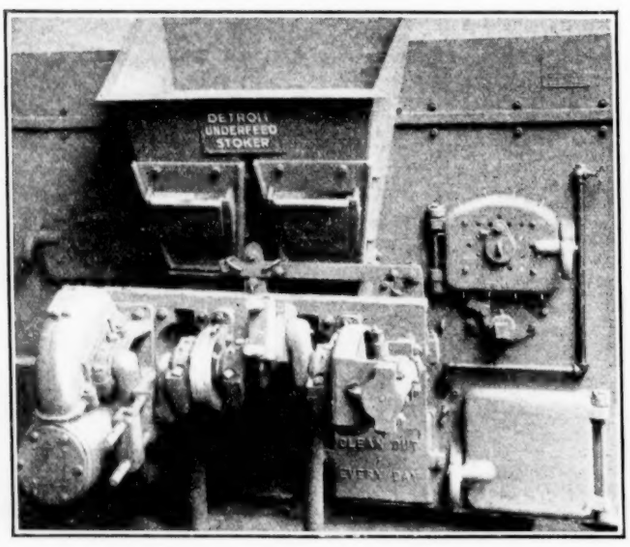


Fig. 1—Front view of stoker

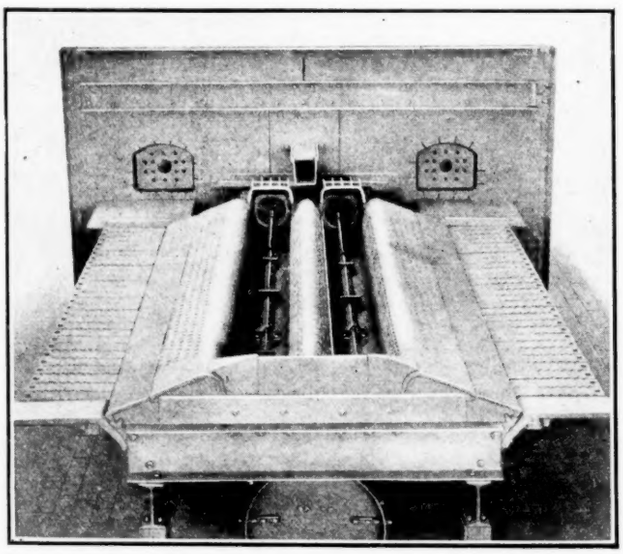


Fig. 2—View of stoker assembly

Striking a Balance in Industrial Power Plant Design

IN a paper presented before the Midwest Power Conference, Chicago, on Jan. 28, Paul L. Battey emphasized the importance of balance in the design of an industrial power plant. While important, he believed that mere technical or thermal efficiency in the plant does not make up the entire problem. Commercial or investment efficiency must be given the proper weight in the analysis and in his opinion the most vital factor to be considered is the use factor. No attempt was made to present figures as to efficiency values, but to set out the relation of factors in such a manner that the entire problem might be visualized and a better co-ordination or balance be reached.

Balancing Factors Involves Many Characteristics

In the design of the industrial plant this problem of balancing factors involves more diversified characteristics than are found in the power plant for commercial service. Not only must the power demand, diversity and consumption factors be obtained, but the requirements in terms of these factors be determined for process steam, heating, air compressors, pumps for various other service systems, and these under all seasonable variations; in other words, both the daily and annual demands, diversity and load factors are necessary.

Where the steam requirements for power production exceed those for process and other purposes, under the full range of conditions, consideration should be given to outside commercial power service and the amount of the excess should indicate the extent to which the purchase of power economically may be considered. Where the process heating and miscellaneous service steam exceeds that required for power generation, in almost every case the local industrial power plant for all services is justified, although even here it may be found that a saving can be made by partial purchase of power under a carefully worked out schedule extending over the entire year.

Records of Operation Necessary

For the purpose of analysis, preliminary to design, correct and continuous records of operation are essential. Plant design and consideration of power purchase contracts should be based only on the over-all annual range of conditions and not, as is frequently the case, upon tests of one or a few days.

With a thorough understanding of all conditions and their relation, a sound use factor for each item of equipment may be determined. The term "use factor" covers both that of load and diversity and is applied to an annual basis of time consideration. The use factor reflects the economic aspect of investment, depreciation, taxes, insurance and, to a certain extent, maintenance and labor, and these items represent from 50 to 55 per cent of the cost of the electric power production, while fuel, operating labor, supplies and most maintenance constitute the remainder. Of the latter the fuel varies from 25 to 35 per cent of the total cost, so that it is obvious that anything accomplishing a 10 per cent increase in the use factor will show twice the over-all saving that 10 per cent reduction in fuel consumption affords, assuming, of course, that the plant capacity is equivalent to the demand factor.

Improvement in Economy of Steam Generation and Use

In recent years marked improvement has been made in the economy of steam generation and in the use of this steam in prime movers. It should not be lost sight of, however, that this increase in operating efficiency is to a great extent obtained at the expense of a considerable increase in plant investment, and unless full consideration is give to the use factor of the equipment, the investment efficiency may outbalance the thermal efficiency.

Improvement in use factor generally centers around the co-ordination of the various plant-service systems, taking advantage of all possible diversity of time of demand among them. While the industrial plant has not the degree of diversity found in commercial service, there is more opportunity to co-ordinate the different services, as all services are subject to one management instead of a number who have no interest in common. Some scheduling of factory operation is often possible which will help the power plant without upsetting production programs. Also, plant use factor may be increased by the installation of storage reservoirs or tanks so that water may be pumped at off-peak periods or more continuously at reduced rates. Steam accumulators may be used for evening up the varying load from a number of units requiring process steam, and there are numerous other things that may be done to promote the same end.

Continuous Outlet for Product

Increasing the use factor of plant equipment is comparable to the building up of an industrial business by increasing and distributing over the year, the sale of the product. No matter how efficient the plant may be in operation, unless there is continuous outlet for the product, earnings are doubtful. Traffic density of a railroad is another name for use factor. It is well known that the investment required for railroad electrification is justified only by heavy traffic density, even though electrical operating expense is much less than for steam.

Power-plant engineers should look for extended and diversified use of power-plant facilities and services within the factory, reducing the percentage of non-productive expense thereby. Conversely, they should look for unnecessary losses of all kinds, and these always are to be found in the average industrial plant, such as losses of steam, compressed air, water, reduced electric generating and distribution capacity due to poor power factor of underloaded induction motors driving factory equipment, and many other items that always should be under surveillance in order that full useful output of the power plant be available before extensions are considered.

Numerous illustrations were cited, bringing out the great importance of use factor in industrial power-plant design, and throughout it is made evident that the higher the use factor of each item the greater the justification in increased investment for the more efficient modern apparatus.

Steam Prime Movers

A large proportion of industrial plants call for the installation of steam prime movers because of demand for process and heating steam. There are, however, many industries where oil engines of the Diesel type are better adapted to the requirements. The conditions particularly favoring the oil engine are a high use factor of probably 50 per cent or better, because of the relatively large investment per unit of capacity, and where oil for fuel is favorable as to cost and available supply as compared to coal, and where there is no demand for process steam. In some classes of plants heating can be taken care of in a satisfactory and economical manner by the use of a pressure hot-water system utilizing the jacket circulating water from the engines and the waste heat from the exhaust gases through heaters suitable for this purpose.

As to the arrangement of the equipment in the power plant, there is a growing tendency toward multiple unit grouping, and this applies also to units other than those for electric power generation. Provisions for future extensions to plant always should be given careful attention. The capacity of individual units should be coordinated with the demand fluctuations of the various service systems and the operation of units should be carefully scheduled to best suit these variations in order that the greatest operating efficiency may be obtained at all times. It is surprising how little attention is given by operators to economic scheduling.

Improved Equipment Now Available

For steam power plants there is now available much improved equipment. Greatly increased boiler capacity per square foot of heating surface, due to properly proportioned stokers or pulverized-coal units, is a remarkable example of increasing the use factor of boiler-heating surface. The more recent high-pressure steam equipment has great possibilities for adaptation to industrial plant use, where process steam is required in manufacturing operations. Possibilities for balancing steam demand for power generation with process-steam requirements are much enhanced. The use of high-back-pressure and bleeder turbines opens up a wide range of improvements in the use of steam for both process and heating. Extensions to existing plants by the use of high-pressure units and arranging these to exhaust to present

medium-pressure equipment and then to process systems, offer opportunities not only for increasing thermal efficiency, but also for conservation of existing investment.

Equipment for establishing and maintaining proper combustion conditions in boiler furnaces, proper feedwater treatment and heating, should be provided. The use of pulverized-coal equipment, particularly the more recent unit pulverizers, offers interesting possibilities of increased boiler efficiency without undue increase in investment.

Representing as it does from 25 to 35 per cent of the total cost of power production, the fuel supply is an important factor. Preliminary coal analyses are essential not only for determination of B.t.u. value, but composition, particularly ash content. Both have an important relation to freight charges from the mine as well as to the adaptation of the physical equipment. Further, the reliability of the source of supply, including the number of different points from which similar coal may be obtained, is another factor to be considered. Under present-day mining conditions, provision for the storage of coal is important, as industrial plants cannot afford to take the chance of interrupted supply, and here there is another point to be considered, as the character of the coal is a factor in its satisfactory storage.

Reference was made to the trend toward the decentralization of industrial plants in which electric power and light service, electrically driven pumps for fire protection, general water service, air-compressor units, etc., are distributed at departmental load centers, with a view toward higher efficiency in both investment and operation, better allocation of departmental costs and lower total costs of production. Depending upon conditions, the electric service for these various departmental services may be purchased or supplied from an industrial plant.

The final message of the paper was "to look to the use factor and give it full weight in design." Every industrial installation involves the efficient use of money, sound investment, efficient operation of equipment and improved technology. The success of the designer will depend on how nearly he can strike the balance and find the differential between these prime factors. Solving this equation calls for good engineering, intelligent analysis, judgment born of experience and not a little plain common sense.

Parallel Operation of Steam and Hydro-Electric Plants*

By L. F. Harza†

A VAST amount of study has been devoted to the subject of operation of steam stations to insure maximum fuel economy, because of the evident importance of fuel economy to steam power costs. On the other hand, operation of hydro-electric plants has not, in general, been given the amount of study and intelligent supervision necessary to obtain not only the maximum energy output from a given installation, but also the maximum service to the system as a whole that its importance deserves. The same intelligent supervision should be given to hydraulic plant operation, and with such supervision the output and usefulness of a hydraulic plant could in general be appreciably increased.

It is often said that the capital cost of a hydro-electric plant is so much larger than the capital cost of a steam plant, that the increased fixed charges tend to offset largely the reduced operating costs arising from the lack of fuel requirements. This statement, however, is very misleading in some respects. It is the cost of the dam, overflowed lands, bridges, highway changes, and various similar items that causes the cost of a hydro-electric plant to exceed the cost of a steam plant. Having already provided a dam with all its incidental costs, then the power-generating station with its intakes, penstocks, machinery and building substructure and superstructure can be built more cheaply than a steam station per unit of capacity for heads of about 25 ft. or greater, assuming the capital investment in the steam station to be $125 per kilowatt. For a head of 50 ft., the hydraulic generating station costs only about two-thirds of the cost of a steam station and for a head of 100 ft., costs less than half as much, based of course upon general average conditions, since two sites are never identical.

If a hydraulic station is justified on the basis of its energy output at system load factor on a competitive basis with the average steam cost of a given system, then this hydraulic station can be provided with excess capacity for serving peak loads at less than system load factor more cheaply than the steam capacity of the system can be increased for peak load service. In other words, instead of the general opinion that a hydraulic plant must suffer from higher fixed charges, the fact is that an increase in capacity of the hydraulic system above that required for base load can be secured often at considerably less investment cost than an increase in steam capacity, and at the same time will require no fuel cost for its operation.

Now the cost of serving the peak load of the system is not six mills or eight mills or one cent per kilowatt-hour by steam, but is usually very much greater than this. The shorter the duration of the peak load on the system, the smaller is the load factor of the equipment installed to serve this peak load and the higher the proportionate fixed charges as well as fuel consumption per kilowatt-hour applied to the energy generated during the peak. It is in this field that the dependable hydro-electric project can accomplish the greatest good to a steam system.

On the other hand, a hydraulic station equipped to utilize during the peak-load hours the entire water supply of its dry season will usually, during wet seasons of the year, have water enough to run continuously perhaps at its full capacity, thus displacing base-load capacity at other than peak-load hours and thereby reducing the load factor on the steam plant during such times, to the disadvantage of the latter's unit cost of energy.

Maximum Service

The ideal equipment of a hydraulic station for maximum service then consists of multiplication of capacity to the limit of available water supply and available daily storage, for the purpose of carrying as much as possible of the daily peak of the system during the low-water or dry season of the river and the use of this capacity to the limit of available water supply during high-water seasons, to the exclusion of an equivalent amount of steam capacity. This subject has been enlarged upon in an able paper by F. A. Allner, member of the American Society of Mechanical Engineers, entitled "Parallel Operation of Hydro and Steam Plants." September, 1925, issue of *Mechanical Engineering*, and will not be further considered here. The principal point which I wish to emphasize is the reverse of the usual opinion; namely, that additional capacity of hydraulic power for heads above 25 ft. at least, is usually cheaper in first cost of installation than steam power after construction of the initial structures, a point which Mr. Allner did not bring out.

In the combined operation of steam and hydraulic systems, conflict and jealousies frequently arise, unless the operation is under one head. This head must be a man of remarkable impartiality and in continuous hourly contact, through the load dispatcher, with the conditions existing on the entire system. The operator of every steam plant on the system is naturally anxious to produce as big an output and to maintain as good a load factor on his station as possible, and thereby make the best showing to his superior on unit costs of production. A hydraulic plant feeding into the same system interferes more or less with these ambitions and may at times increase the unit costs. Thus in a period of surplus water, it is of general economy to the system to utilize the hydraulic plants to the maximum extent of available water supply, but to do so may not only reduce the operating capacity, but also the load factor and thereby increase the unit costs of parallel steam stations, although reducing the total operating costs of the system. At such times the steam-plant operator must yield to the greater good of the system and in general can be induced to do so only by the superior authority of a load dispatcher who has in mind only the total operating costs of the system rather than the economical showing of various units thereof.

*Abstract from a paper "Suggestions Regarding Hydraulic-Plant Operation," presented at the Midwest Power Conference, held in Chicago, Jan. 26 to 29, 1926.

†Consulting engineer, Chicago, Ill.

Recent Publications

Principles of Metallurgy of Ferrous Metals. By Leon Cammen, M.A. Published by the American Society of Mechanical Engineers, New York, 1926. Size, 6x9 in.; 145 pages; illustrated. Price $2 ($1.50 to members).

Those who have read Mr. Cammen's excellent series of articles in *Mechanical Engineering* will be glad to know that these are now available in book form. The book is a complete reprint of the series of articles, without additions. The Society is to be commended for this step, which collects in form readily understandable to mechanical engineers, a statement of the present state of metallurgical knowledge and theory. The book should prove of considerable value to those who desire to bring their knowledge of metallurgy up to date.

Draft and Capacity of Chimneys. By J. G. Mingle, C. E. Combustion Publishing Corporation, 11 Broadway, New York City, 1925. Size, 5½x8 in.; 329 pages, plus 9 pages of index. Numerous tables and charts. $3.50.

This book discusses the subject of chimney design and capacity with exceptional thoroughness and presents an elaborate equipment of formulas and a number of charts for their solution. Unfortunately, most of these charts are reduced almost to the point of complete illegibility.

One or two topics are worked out which the reviewer believes have not previously been published. The author shows that the capacity of a chimney, varying with the flue-gas temperature, is a maximum when the absolute temperature of the flue gas is approximately twice the absolute temperature of the outside atmosphere. Its practical value may be open to question, but the fact is interesting from a theoretical point of view. Further, the author works out a formula for the chimney-gas velocity which will lead to the design of a chimney of minimum total cost, on the assumption that the product of height by diameter is proportional to the cost of the chimney. In doing this he has deemed it necessary to make a number of simplifying assumptions and approximations, so that the final result is open to some question, but the effort is at least interesting.

Throughout the book there are a number of curiosities of nomenclature. For example, the author states that one quantity varies as another in cases in which proportionality is obviously impossible. In speaking of curves as convex or concave upward or downward, the author frequently uses these terms in the reverse of their usual significance. The scheme of symbols chosen is unfortunately difficult to remember.

In his numerical illustrations the author carries a ridiculous number of significant figures. The density of air, for example, is carried to five significant figures, and chimney heights are calculated to one-tenth of a foot. Much space is given to arguments combating the use of certain methods of computation that the author quite correctly maintains are not rationally established, although some of them have been used with satisfaction for many years. In some cases the argument is not convincing. Throughout the book there is a noteworthy absence of a logical plan of procedure and a surprising amount of extensive repetition of both argument and subject matter.

The discussion includes topics only remotely related to the subject, and their treatment is inaccurate and obscure. It is deplorable that writers in the field of heat generating or using machinery, whatever the restrictions of their activities, seem unable to refrain from the discussion of general thermodynamic theory, despite the fact that in some cases their ideas may be fantastic.

The book should prove useful to those who have to design chimneys and who have adequate training and experience to guide them in the choice of material. For the beginner, on the contrary, it is feared that the book will be confusing owing to the discussion of more or less irrelevant topics, to the generally unsatisfactory nature of this discussion, to the presentation of several methods of computing some quantities, to the divergent point of view of various chapters and to the prevalent combative atmosphere of the book. The inexperienced reader needs a simple direct discussion of the subject, which could be given in much less space than the author has required for his rambling and argumentative treatment.

Signal Wiring. By Terrell Croft. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, 1925. Cloth; 5½x8 in.; 348 pages; 463 illustrations. Price, $3.

Signal systems have been devised for an almost countless number of purposes and involve a great variety of wiring schemes. In this book the author has brought together a collection of 463 wiring diagrams for signal systems, comprising bells and annunciators, burglar alarms, hospital and hotel signaling; time and program-clock circuits; autocalling signaling circuits; telephone circuits; fire-alarm circuits; watchman and police-call circuits; power-station signaling; water-flow and pressure alarms; elevator signaling; mine signals, railroad signaling; miscellaneous signaling devices; and signal-wire methods.

Very little text matter is given with the wiring diagrams for the reason, as set forth by the author in his preface, that those who install and maintain this equipment are interested chiefly in how the apparatus is connected and what the circuits are. The diagrams given have been selected with the object in view of meeting the requirements of the average electrical worker. The last chapter deals with the National Electrical Code requirements; conductors and cables; protection; installation of circuits; batteries; motor-generator sets; transformers, etc. The author has brought together in a convenient form a lot of information that has not been available before except as it was scattered through a great many sources. For those who are interested in signal systems, the book has much to recommend it to their attention and use.

John Frank Stevens—The presentation of the John Fritz Gold Medal to John Frank Stevens, March 23, 1925, by the John Fritz Medal Board of Awards of the Four Founders societies. This book contains copies of speeches made at the presentation exercises as well as a biography of Mr. Stevens and other material connected with the ceremonies.

Tests of Fuel Savers for House Heating Boilers with Appendices on Oil Heating and Economical Use of Coal, by F. G. Hechler, is Bulletin No. 34 of the Engineering Experiment Station of the Pennsylvania State College. Published by the Pennsylvania State College, State College, Pa.

Value of Bituminous Coal and Coke for Generating Steam in a Low-Pressure Cast-Iron Boiler, by C. E. Augustine, James Neil and William M. Myler, Jr., is Technical Paper 367 of the Bureau of Mines. Sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents.

Tentative American Standards, Tolerances, Allowances and Gages for Metal Fits. Approved by the American Engineering Standards Committee, Dec. 1925. Published by the A.S.M.E., 29 West 39th St., New York City. Price 50 cents.

Pacific Drainage; British Columbia and Yukon Territory. Water Resource Paper No. 47 covering the climatic year 1923-24. Published by the Dominion Water Power and Reclamation Service of the Department of the Interior.

International Railway Fuel Association—Proceedings of the Seventeenth Annual Convention. Published by the society, J. B. Hutchison, secretary, 1809 Capitol Ave., Omaha, Neb. Limp cloth, 6¼x9¼, 526 pages, price, $3.

Analysis of Alabama Coals—Technical Paper 347, Bureau of Mines. Apply to Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 15 cents.

Comparative Accuracy of Three-Phase, Four-Wire Metering Methods, by D. T. Canfield. This is the title of Bulletin No. 13 of the Engineering Extension Department, Lafayette, Ind.

The Locomotive of the Hartford Steam Boiler Inspection & Insurance Co. Vol. 35, 1924-25. Published by the Hartford Steam Boiler Inspection & Insurance Co., Hartford, Conn.

News in the Field of Power

Bureau of Mines Oil Shale Plant Completed

To complete preparations for the opening of the Bureau of Mines experimental oil shale mine, Dean Frank H. Probert, one of the Bureau's consulting engineers, is en route to Washington to confer with Director Turner. The treatment plant has been completed. It is planned to mine 5,000 tons of shale this summer.

Conowingo Financing Opposed by Governor Pinchot

Determined opposition to the financing plans for the Conowingo hydroelectric power project is expressed by Governor Pinchot in a letter on Feb. 13, to the Federal Power Commission, at Washington, according to the *Philadelphia Public Ledger*.

The Governor's letter said:

> Under the financing plan proposed to you by the applicants, all the control will ultimately be in the hands of the holders of common stock, who will not have invested a dollar, and all the investment will have been made by the holders of the bonds and preferred stock, who will have no voice in the management.

To prevent this situation from arising, Governor Pinchot urges the Federal Power Commission to refuse to authorize the issue of any non-voting stock for the Conowingo project.

The Governor urges, also, that the Federal Power Commission should insist that the securities to be issued for the project shall be equivalent, at par, to what the project will cost, and no greater in total than the actual amount of money properly invested in the project.

The Public Service Commission Law of Pennsylvania does not empower the State commission to regulate issuance of securities. So the Governor declares that "the only protection of our people in this case is the power given your commission to regulate security issues for financing projects licensed by you whenever the State commission concerned is not authorized to do so." Governor Pinchot therefore suggests to the Federal Power Commission:

> That you refuse authority to issue stock in excess of the amount which, added to the proceeds of the bonds authorized by you, will equal the net investment in the project.
>
> That you refuse authority to issue any no-par common or other stock, but, on the contrary, that you require all stock to have a fixed par expressed in the stock certificates.
>
> That you refuse authority to issue any non-voting preferred or other stock.

The proposed bond issue of $38,000,000 at 5½ per cent, declares the Governor, with the proposed issue at par of $16,000,000 of preferred stock will provide $54,000,000—"enough to pay the estimated cost of the project."

"The additional 94,200 shares of common stock whose issue you are asked to authorize," says the Governor's letter, "can serve no purpose but that very speculation in unearned increment which the Federal Water Power Act was intended to prevent."

Another Muscle Shoals Bill Introduced

With the idea of requiring the distribution of Muscle Shoals power throughout "the full radius of its economic use," Senator Ransdell, of Louisiana, a member of the committee having jurisdiction in the Muscle Shoals matter, introduced a bill providing for the allocation of all power by the Federal Power Commission and the transfer to that agency of all the government's Muscle Shoals properties.

The power is to be leased only for public-utility purposes, although provision is made for the local use of such power as may be necessary to conduct experiments in nitrogen fixation, with other fertilizer ingredients, and with electrochemical and electrometallurgical processes in which power is an essential requirement.

In introductory whereases Senator Ransdell makes it clear that he does not believe the government should go into the power business or the fertilizer business. He makes the point that while "it is the duty of the government to foster beneficial arts and sciences, it also is the duty of government to refrain from engaging in competitive business in which its citizens are engaged." He thinks, however, that the government can contribute greatly to the welfare of the farmers by doing research work on fertilizers at Muscle Shoals. He points out that there still is much to learn concerning the art of nitrogen fixation and concerning the manufacture of other fertilizer ingredients. His bill provides that private inventors and investigators of these processes may have an opportunity to work out their ideas at Muscle Shoals, where the government will supply them with the necessary facilities. When the best method of manufacturing nitrogen shall have been developed and when it will have been demonstrated that synthetic nitrogen can be produced at a cost that will allow it to compete with Chile saltpeter, private enterprise then will be willing, he believes, to lease the nitrate plant at Muscle Shoals without demanding a subsidy in form of power.

The bill also provides for experimentation on the part of the War Department and the Agricultural Department, the agencies concerned principally with nitrogen fixation.

Senator Ransdell took an important part in the defeat of the Ford offer. He is opposed to the House resolution, now on the Senate calendar, because it holds up the Ford offer as a model to the proposed joint Congressional committee, and because it does not provide for the distribution of any power not actually required for the manufacture of fertilizer.

Stokers Sold During January, 1926

The Department of Commerce announces that during the month of January, 1926, there were sold 72 mechanical stokers, which were installed under 10 fire-tube boilers of 13,880 sq.ft. of heating surface and 62 water-tube boilers of 355,250 sq.ft. of heating surface. These statistics were compiled from reports received from 13 establishments.

John Fritz Medal To Be Awarded on March 30

The John Fritz Medal Board of Awards, representing the A.S.C.E., A.I.M.&M.E., A.S.M.E. and A.I.E.E., has issued invitations for the ceremonies attending the presentation of the John Fritz Gold Medal to Edward Dean Adams, which will be held in the auditorium of the Engineering Building, 29 West 39th St., on the evening of March 30.

The speakers announced are: Honorable James Montgomery Beck, formerly Solicitor-General of the United States; Arthur Edwin Kennelly, professor of electrical engineering, Harvard University and M.I.T.; Major Fred J. Miller, chairman of the Board making the award; Edward Dean Adams, medalist; Frank B. Jewett, presiding.

1925 Petroleum Production Greater Than 1923

According to preliminary figures issued by the Bureau of Mines, compiled from reports of companies that operate gathering lines, 755,852,000 bbl. of petroleum were transported from producing properties in the United States during 1925. Final production figures, which will include the quantity of petroleum consumed for fuel on the leases and the net change for the year of stocks held on producing properties, obtained from the annual canvass of producers, may show a total output for the year of approximately 764,000,000 bbl. This is an increase of 7 per cent over 1924 and of 4.3 per cent over the previous high figure of 1923.

Preliminary figures and estimates indicate that the world production of crude oil in 1925 will be in excess of 1,060,000,000 bbl. and may possibly amount to 1,070,000,000 bbl. This is an increase of 5.5 per cent over the 1924 output, which was largely due to the 50 million barrel increase in the United States. Production in Mexico fell off 25 million barrels, but gains were made in most of the other important foreign oil-producing countries, notably Venezuela, which, for the second successive year, more than doubled its output and now has a daily production of fifty times what it was five years ago.

Governor Smith Again Challenges the New York State Water Power Commission

Says Power Corporation Has Capital Stock of $20,000 to Develop 500,000 Hp. in St. Lawrence River—Asks Names of Real Backers of Corporations Seeking Grants

REPLYING to an interview with Attorney General Albert Ottinger, published in the *New York Times*, Feb. 9, in which the Attorney General defended the policy of the New York State Water Power Commission for the development of the state's water-power resources by private corporations under state control and criticized the Governor's water-power program, which contemplates development under state auspices, Governor Smith, in a statement made public, Feb. 16, urged that a little light be let in on the corporations which at present are applicants for hydro-electric leases from the state.

Mr. Ottinger in his interview said that he did not care whether hydro-electric current was developed under state or private auspices so long as it was developed for the benefit of consumers.

The text of the Governor's statement follows:

My attention has been particularly attracted to an interview appearing in the newspapers the early part of last week in which the Attorney General sets forth clearly his position on water power.

I am in no way attempting to coerce the State Water Power Commission. They have placed upon them by law the duty of considering applications for long leases to take water from the boundary streams and other portions of the state for the development of electrical energy. The Attorney General says I do not care whether we have development through private enterprise or by state initiative.

The difference between the Attorney General and myself is that I do care. I am opposed to the leasing of these water-power rights for long terms to private corporations for their own profit, and I favor the development at the site by the state itself so that the sources of all power may remain in the hands of the people themselves.

For that reason I am endeavoring to have the law changed under which the Attorney General feels it is his duty to act. I am following the principle set down by Chapter 569 of the Laws of 1907, which directed the State Water Supply Commission to devise plans for the progressive development of the water powers of the state for the public use under state ownership and under state control. This enactment undoubtedly resulted from the recommendation of Governor Hughes in his message to the Legislature on Jan. 2, 1907, when he stated they (water powers) should not be surrendered to private interests, but should be preserved and held for the benefit of the people.

The Attorney General says that a rough estimate places the cost of developing the potential power controlled by the state on the St. Lawrence and Niagara rivers at $100,000,000. It might be well for the Attorney General to tell the people of the State of New York just who the applicants for these valuable water-power rights are.

According to the report of the New York State Water Power Commission, signed by the Attorney General, there is only one applicant for the waters of the St. Lawrence River in the vicinity of Croil Island. The report states that there is there available 500,000 hp. At the estimated cost suggested by the Attorney General at least $100,000,000 will be required for this particular development. The only applicant for it is the Louisville Power Corporation.

According to the records in the office of the Secretary of State, the Louisville Power Corporation came into existence on the 21st of October, 1919, and has a capital stock of $20,000. In the papers of incorporation it failed to mention the place of its principal office. Its directors are Walter F. Wilson, of Louisville, N. Y.; Weber Allen Warren, of Massena, N. Y., and George P. Matthew, of Massena, N. Y.

The question naturally arises, who is the Louisville Power Corporation? What is it, and who is financially responsible? In other words, who owns it and who, therefore, are the real applicants for this valuable grant of water power?

According to the report of the Water Power Commission there is another 500,000 hp. available at the Long Saulte Rapids. The only applicant for this right is the St. Lawrence Valley Power Corporation with its principal office in the village of Potsdam, St. Lawrence County. The same questions arise as to this application. Who owns the St. Lawrence Valley Power Corporation and who is behind it?

According to the report, the Lower Niagara Power & Water Supply Co. is the applicant for the 150,000 hp. available for the waters of the Niagara River in the Niagara Gorge. This company was brought into existence twenty-four years ago by a special charter under Chapter 539 of the Laws of 1902. With its principal office at Lewistown, N. Y., according to the records in the office of the Secretary of State, the seven directors did not state their places of residence, and the question again arises who really owns the Lower Niagara Power & Water Supply Co. and what is its financial responsibility to undertake a $30,000,000 improvement in the gorge at Niagara Falls?

A reading of the old charter puts it in the class of general grants that were made years ago, wherein power is given to this company to condemn private property except that used for railroad purposes for the laying of conduits, pipe lines, wires and various other appliances required in its business. Who knows but that this grant may put life and vitality into an old time charter that in the enlightened age in which we are living today would never be granted?

Before anything happens, a clearcut discussion of all of the above would be beneficial to the people of the State.

Attorney General Ottinger said on Feb. 14, that the identity of those seeking hydro-electric leases on the St. Lawrence and Niagara undoubtedly would be disclosed in due time. It is understood that the Aluminum Co. of America is behind the St. Lawrence River application. The Lower Niagara Co. recently was included in the Northeastern Power Corp. merger, of which H. Edmund Machold, former Speaker of the Assembly, is the president:

Attorney General Ottinger said:

All these matters will be gone into at the public hearings that the Water Power Commission will hold on these applications later this month. The important thing, and the thing I am interested in now, is that the power is developed and distributed to consumers. The Water Power Commission can put in restrictions to see that the power is made available to the general public and not consumed industrially at the site. I see no occasion for extended reply to Governor Smith's statement.

In the charter the Lower Niagara Co. obtained in 1902, James S. Simmons, James Low, John F. Lynch, George W. Knox, Marion P. Hatch, George E. Green and their successors appear as incorporators. The charter provides for a maximum capital stock of $5,000,000.

Under its 1902 charter the corporation was empowered to "take and acquire by condemnation any real property or right, interests or easement therein except the property of a railroad, for the laying, relaying, repairing and maintenance of its conductors, cables, wires, insulators and pipes for the purpose of supplying and conducting water or furnishing light in public places or power for transportation."

The rights, however, were restricted to Niagara County. It was pointed out here tonight that should the company receive at the meeting of the Water Power Commission on Feb. 25 a final permit for water-power development, it would be empowered under the present Water Power act to exercise the state's right of eminent domain for purposes essential to the building of its plant and transmission of power developed.

Tennessee Tackles Smoke Question in Practical Way

Prof. W. R. Woolrich, of the College of Engineering, University of Tennessee, and author of "Power Plant Economy," organized a class for stationary engineers at the Hume-Fogg High School in Nashville, Tenn., on the evening of Feb. 12, to study better economy in the operation of power plants, particular attention being given to reducing the smoke due to imperfect burning of fuel.

This class is to be open to all engineers of the city without fees. All expenses are being born by the University of Tennessee, the Manufacturers Association and the Smith Hughes funds for vocational education.

Arrangements are being made for Professor Woolrich, who has served in every power-plant job from fireman to chief engineer, to conduct similar classes in Chattanooga, Memphis and Jackson. His work with the stationary engineers in Knoxville has been so successful that the University of Tennessee has asked him to extend his services to other industrial centers of the state.

Co-operate with Government Theme of Utility Conference

Representatives of some of the leading public-utility interests in the United States and Canada held a meeting at Chicago on Feb. 6, in the office of the H. M Byllesby & Co. organization. "Co-operation with the government," in development of water powers under the jurisdiction of the United States was the subject of the conference, which was presided over by Col. William Kelly, director of engineering of the N.E.L.A. Among the organizations represented were: the Insull companies, Stone & Webser, Hodenpyl, Hardy & Co., Henry L. Doherty & Co., the Pacific Gas & Electric Co. and the Pennsylvania Water & Power Co. Colonel Kelly and C. F. Hirshfeld, chairman of the technical section of the N.E.L.A., represented that association.

These representatives agreed on a program to be recommended to the public policy committee of the National Electric Light Association under which the problems and difficulties at present encountered by the Federal Power Commission and other public authorities, as well as private interests, will, it is believed, be eliminated or greatly reduced.

While technical details of the plan were not made public, it was announced that it will be submitted to the public committee of the N.E.L.A. for official presentation to the government.

Engineers Hold Conference on Power in Industrial Plants

Philadelphia Engineers' Club Devotes All Day and Evening Sessions to Discussion of Generated Versus Purchased Power

THE importance of industrial power was exemplified by a general conference on this subject at the Philadelphia Engineers Club on Feb. 16, at which the attendance at all three sessions taxed the capacity of the hall. The problem was discussed from all angles, including that of design and operation of the private plant as well as from the central-station viewpoint, and the consensus of opinions appeared to justify the private plant in most cases where substantial quantities of process steam are required. Each plant, however, presents an individual problem that must be considered on its merits, and generalization is likely to lead to erroneous conclusions. Advantage is being taken of higher steam pressures together with the bleeder turbine for effecting better heat balance conditions. Several speakers emphasized the desirability of exchange of power between utilities and large industrial plants.

In a paper on "High Pressure Prime Movers in Industrial Plants," Francis Hodgkinson pointed out that in the design of small-capacity turbines, where the high-pressure volumes are small, it is difficult to design the high-pressure elements of so small an area that the turbine can avail itself of the pressure and be efficient. Such difficulties can be met, however, by employing high rotative speeds and gearing. Combinations of high- and low-pressure elements may be furnished in which any proportion of steam may be delivered at any of the lower pressures for a variety of purposes and the extra energy may be secured by turbines expanding additional steam from the boiler pressure to a condenser pressure. "This, after all," said the speaker, "is cheap energy, as all the fixed losses in the turbine and generator have been taken care of and, by virtue of the large volumes passing the high-pressure turbine elements, the turbine efficiency may be increased. In fact, with the charges in the industrial power house properly apportioned, the public utility will find it hard to compete. Unfortunately, there are so many varieties of pressures and ratios of process heating requirements to energy requirements, that the problem is difficult to meet with standard apparatus, requiring either high fixed charges because of special development, or lowered efficiency because of attempts to use standard apparatus."

Mr. Hodgkinson expressed the opinion that in many cases where steam is not required for process but for heating only, the installation of non-condensing turbines is justified provided satisfactory arrangements can be made with the utility company for the supply of energy during the non-heating period.

Samuel M. Green, consulting engineer, of Springfield, Mass., discussed the use of exhaust steam for process work in textile plants. "In such plants," said the speaker, "all the processes require heat at some stage and 98 per cent may be furnished by steam at or below 20 lb. gage." It is necessary, however, to convince the superintendents and foremen that 12- to 15-lb. steam will dye goods as well as 80-lb. Automatic control to maintain a temperature between 202 and 206 deg. is of great assistance.

Finishing plants have been operated for many years by large engines driving lineshafting and by small engines driving machines requiring variable speeds. The exhaust from these engines is used for process work, but in many instances there is more exhaust than can be used because of the very large amount of steam used by these small engines. Therefore engine drives are being replaced by steam turbines and electric motors. In general, the steam required by any finishing plants for process work will, if passed through properly designed power apparatus, generate more power than is required for finishing.

In cases where the demand for process steam always exceeds the amount of steam required to produce the necessary power, back-pressure turbines should be used. Where the demand for process steam exceeds the steam required to produce power for a portion of the day and for the rest of the day the process steam required is less than needed for power, bleeder or extraction turbines should be used with a condenser.

Factors Governing Purchase or Generation of Power

W. A. Shoudy outlined the considerations that must be satisfied in deciding upon the generation or purchase of power, after having first determined if satisfactory utility power can be obtained. These include "use factor," "fixed charges" and "operating costs." Equal in importance to equipment performance is the efficiency of the personnel which accounts largely for the average fuel consumption never equaling that obtained under test. The total plant efficiency he characterized as the product of the mechanical and the personal efficiencies.

The main classifications based on fuel cost under which any industrial plant is justified in generating its own power, are:

1. When power requirements are large and when sufficient condensing water can be obtained.

2. When the entire power can be generated as a byproduct.

3. When through co-operation of the industrial plant and the utility the entire steam or heat demands are used for the generation of byproduct power and the difference either purchased from or sold to the local utility. The latter procedure would be feasible only in the cases of large blocks of power and under equitable arrangements as to price.

Mr. Shoudy showed that while the best central-station perf rmance is a kilowatt-hour on about 14,000 B.t.u., with the average running from 16,000 to 20,000 B.t.u., a well-designed and properly operated industrial plant, in which power is generated as a by-product from process steam, can generate a kilowatt-hour or about 5,500 B.t.u. This is possible however only where a proper balance is obtainable between the heat demand and the power demand, as for instance in sugar refineries.

Operating a Large Office Building

From the operating viewpoint, Thomas V. Balch told of some of the methods responsible for the excellent results obtained in the plant of the Equitable Building, New York, which has been successful in competing with central-station service. First in importance Mr. Balch placed the creation of a proper spirit of co-operation and loyalty among the operating force; next an adequate metering system whereby accurate records could be maintained of all services and waste detected. At this plant a constant watch is maintained for unnecessary waste through the stack, the atmospheric exhaust and traps discharging to the sewer. In fact, every trap is inspected weekly. With fuel oil and preheated air, as employed at the Equitable Building, they are operating regularly at over 80 per cent boiler efficiency. While all the exhaust from the auxiliaries is now utilized by the ice machines, it is planned to change the auxiliaries over to motor driven. The speaker advanced the suggestion that in designing a new plant for similar service it would be advisable to divide the units into three classes: (1) Those required for base load, which should be of the most economical design; (2) those which would be used only part of the day, or for peak load, which could be of less efficient type; and (3) those for breakdown or emergency service. These last could be of simpler and less expensive design, as efficiency would be unimportant.

Heat Insulation

Heat insulation as applied to the industrial plant was discussed in two papers, one by F. B. McMill n, chief engineer of Johns-Manville, Inc., and the other by R. H. Heilman, of the Mellon Institute of Industrial Research. The former, after taking up in general the savings obtainable through employment of proper insulation, showed the effect of pipe diameter, air circulation and superheat in the radiation from bare pipe as compared with insulated pipe He called attention to the fact that many industrial plants, while careful to insulate steam piping, are apparently unawar of enormous heat waste going on through uninsulated kettles and other process containers.

Mr. Heilman showed comprehensive tables, based on researches at the Mellon Institute, of heat loss from pipes of various sizes and under

various temperatures, both with and without insulation and the corresponding savings in dollars and cents in each case, based on current prices of coverings. In some cases the pipe coverings would pay for themselves in slightly over a month. He next touched briefly upon the history of insulation and discussed the properties of the four principal insulating materials and the effect of various mixtures.

The remaining papers presented at the conference were: "Power Transmission Economics," by William Staniar; "Lubrication and Bearings," by John D. Gill; "Economy Due to Power Factor Correction," by E. N. Dittenhofer; and "Plant Illumination," by Ward Harrison.

Some of the papers will be abstracted more fully in a later issue.

End of Anthracite Strike Surprises the Public

The longest strike in the history of the anthracite industry ended on Feb. 12, when members of the joint negotiating committee of operators and miners, without advance notice to the public, returned to Philadelphia and secretly met on Feb. 11 in separate sessions. The next afternoon they signed an agreement which is to expire on Aug. 31, 1930. This agreement had already been approved by the full scale committee of the union and was submitted to a special tri-district convention of the anthracite districts of the United Mine Workers on Feb. 16.

The delegates ratified the compact, 698 to 2, after speeches by the members of the Miner's Negotiating Committee, who declared that it was the result of one of the greatest victories ever achieved by organized labor in the United States.

They explained that the agreement meant the retention of the right to strike, successful resistance to the demands of the operators for compulsory arbitration, elimination of any possibility of a wage reduction for five years, continuance of present wages for that period and the impossibility of a wage decrease before the expiration of the contract.

According to the press, President Lewis maintained that in deference to the dislike of the word "check-off" by the operators, the term was not used. Instead a clause was written referring the demands of operators and miners "on the question of co-operation and efficiency" to the Conciliation Board, without the umpire, to work out "a reciprocal program of co-operation and efficiency." But "check-off" is what it means, he said.

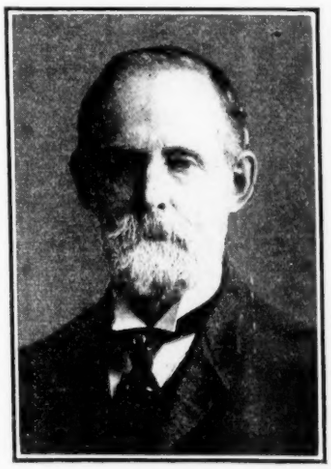
The speakers praised the efforts of Governor Pinchot to settle the strike and of Richard F. Grant, president of the Susquehanna Collieries Co., with bringing both sides to the adoption of the terms of the contract.

Construction is under way on the $500,000 storage and power dam on the Mushkosh River, in the Muskoka Lakes district of Ontario. This work is designed to control the flow from the Muskoka Lakes basin and to link up this power with the Engenia-Severn system, according to *The Engineer*.

W. H. Odell Dies in His 86th Year

William H. Odell, one of *Power's* cherished contributors, passed away on Feb. 15 in his 86th year, at a private home for the aged in Brooklyn, N. Y. His "Reminiscences of a Mechanical Engineer" were published from time to time in *Power*, many of them during the years 1923, 1924 and 1925.

Mr. Odell, who was a genial and unassuming octogenarian, and delighted in his nickname "steam shark," was born at Ardsley, Westchester Co., New York, in 1841. He served for four years as an apprentice in the machinist's trade in Brooklyn, during which time he studied drafting at the Cooper Institute in New York in the evenings. He worked in various machine shops about New York, principally marine shops, rising to the position of foreman, until 1868, when he took a position as engineer with Bald-



W. H. Odell

win & Flagg, hat manufacturers at Yonkers, where he originated a method of boiling the dye kettles with exhaust steam, which up to this time had been thrown away. This change of method resulted in the saving of about one-half of the coal bills. He said on one occasion that he believed this was the first time exhaust steam had ever been used for this purpose. In 1870 he was engaged by the Remington Arms Co., of Ilion, N. Y., as chief engineer but remained only a few months. In 1871 he was engaged by William Wright & Co., of Newburgh, N. Y., as superintendent, where he remained until Mr. Wright urged him to start in business as an expert on the generation and application of steam and thus make a broader use of the knowledge of the science of steam that he had acquired under the instruction of Charles J. Emery.

This business was slow in building, as Mr. Odell was a "few years ahead of the age," as Henry R. Worthington, Sr., said to Mr. Odell at the time, and he often had to seek other work to help out. He was frequently engaged by C. H. DeLamater, Capt. John Ericsson, Henry R. Worthington, Sr., Babcock & Wilcox Boiler Co., George H. Corliss, Thomas A. Edison, Otis Elevator Co., and many other large corporations.

Mr. Odell invented and patented many efficient devices that are in use today. But like many other inventors he did not receive the rewards in a monetary way that should have been his for these inventions, although he retained no bitterness for this treatment.

In 1874 Mr. Odell made the acquaintance of Professor Phinn, who induced him to write an article on the value of the steam engine indicator, which was published in the September, 1874, issue of the *Technologist*. This was probably the first article of its kind ever published in a technical journal.

The year 1880 found Mr. Odell engaged by Sweet & Young, contractors for driving a tunnel under the government grounds at West Point, N. Y., to select machinery for the work. Among the innovations that he introduced in this piece of work was the electric light in place of the usual miners' headlight. It proved a decided success, and Mr. Odell believed that this was the first time that electric light was used in this way.

Mr. Odell's investigations, tests and reports to his clients resulted in the investment of more than $200,000,000 in betterments. His long life was full of interest, triumphs and defeats, but it was well and fully lived and he retained his active mind until the last.

Quebec Power Co.'s Plans

Nearly $1,000,000 will be expended by the Quebec Power Co. in the current year, it was officially announced by Julian C. Smith, president of the company, following the annual meeting recently. Among other improvements the workshops at Limoilou are to be doubled in size.

Tecumseh, Kan., Plant To Be Enlarged

Plans to double the present capacity of the Kansas Power & Light Co. generating station at Tecumseh, Kan., are announced and work is to begin soon. An addition to the present building to house three new boilers, the installation of another generator and the construction of several homes for employees on the power-house site, at a total expense of $1,000,000, make up the program. When it is completed, the rating of the plant will be increased from 15,000 kw. to 35,000 kilowatt.

Steam Reserve Plants Will Prevent Power Shortage

The San Bernardino steam plant of the Southern Sierras Power Co. has been placed in operation to relieve the load on the hydro plants in the north, according to a recent announcement by Robert Newman, district superintendent for the company. The reservoirs in the north are reported to be below normal because of the small amount of water flowing in the streams. No power shortage is threatened for next summer, however, in the San Bernardino district, officials say, since the companies have more than enough steam reserve plants to meet the demands of their customers.

Kentucky Considering New Boiler Inspection Laws

Much objection is being heard from steam-boiler owners to a bill now before the Kentucky Legislature, for creation of a five-man Boiler Commission, and appointment of a host of district inspectors. The office is to be self-supporting from inspection fees, and inspection of all boilers to be made at least once a year, with $5 for external and $10 for internal inspection.

It is claimed that most concerns insure their boilers and that the insurance companies inspect them with capable inspectors, which means that it would merely result in extra cost, and interference with operation, whenever state inspectors felt like investigating.

It is claimed that exemption should be granted all owners of insured boilers, insured with reputable companies. Of course there are many small concerns, rural plants, etc., that do not insure, and it is also claimed that boiler laws in some other states have made Kentucky a dumping ground for worn-out boilers that would not pass inspection in regulated states. There have been cases in Kentucky of boilers blowing up the first time they were steamed, in small lumber and other operations.

Power Plant on Ohio River at Dam 41 Started

The Byllesby Engineering & Management Corporation, Chicago, which controls the Louisville Gas & Electric Co., and Louisville Hydro-Electric Co., was the low bidder when bids were opened at Cincinnati, Feb. 6, for construction of navigation dam, No. 41, at Louisville, to replace the present dam, built a quarter of a century ago, and now obsolete. The Byllesby bid was $2,056,187; United Gas Improvement Contracting Co., Philadelphia, $2,243,997; and Dravo Contracting Co., Pittsburgh, $2,385,832.

The Byllesby interests some time ago, through the Louisville Hydro Electric Co., received the water rights of the Ohio Falls, at Louisville, where a power plant, costing about $6,000,000, will be installed as a separate and private enterprise, license having been granted by the Federal Power Commission. The government dam will be necessary to the operation of the power plant, combining the needed feature of a dam to raise the pool for navigation above Louisville, and impounding water for use of the power plant.

The development will contain eight units each rated 13,500 hp. operating at 37-ft. head, built by the Allis-Chalmers Manufacturing Co. The units will have propeller runners and will be set in concrete spiral casings, discharging through concrete hydraucones. The runners will be approximately 15 ft. in diameter and the mainshaft leading up to the generator will be about 40 ft. long. This unusual length of mainshaft is required in order to bring the generator up above flood water, which frequently rises as much as 65 ft. above its normal operating level. The concrete spiral casings will be about 52 ft. wide, and the units will be set on 58 ft. centers. Cast-iron supports will assist in carrying the weight of the concrete and machinery through the hydraucone to the foundations. The guide vanes for these units will be constructed of plate steel, welded to forged-steel stems and the servo motors and operating mechanism of the guide vanes will be located on the cover plate of the turbine.

Work on the power plant began some time ago.

The bids were received by Col. C. W. Kutz, U. S. division engineer, and forwarded to Washington for action. The new dam is to be completed by Dec. 31, 1928. Its crest will be eight feet higher than the old one which it will replace, and create a fall of 37 feet.

1,800-Lb. Steam Pressure for Czechoslovakia Mine Plant

Steam at 1,700 lb. per sq.in. and 840 to 930 deg. F. temperature is to be used in a new 18,000-kw. station for the Witkowitzer Steinkohlengruben (Coal Mines) in Mährisch-Ostrau, Czechoslovakia, according to information just received from Dr. Jaroslav Havliceek, head of the technical branches of this company. The boilers will be of the type invented by Dr. Löffler and described in the Dec. 29, 1925, issue of *Power*, steam being generated in an unfired drum by the forced circulation of superheated steam from a separately fired superheater. According to Dr. Havliceek there will be three boilers with a combined capacity of 130,000 lb. of steam per hour. These are to be built by the Eisenwerk Witkowitzer. The single 18,000-kw. Lössl design turbine will be built by the Erste Brünner Machinenfabricks. It will be equipped for reheating and for heating feed water by bled steam. Mention of this turbine was made in the June 2, 1925, issue, page 871.

Colorado River Bill Is Difficult to Draft

The Committee on Irrigation and Reclamation of the House of Representatives is trying, rather unsuccessfully, to agree on a bill putting in legislative form a plan for the development of the lower Colorado River along the lines suggested recently by the Secretary of the Interior.

The committee has before it a committee print which has been referred to the Secretary of the Interior and approved by him, with minor modifications.

The unintroduced bill before the committee provides for a dam in the Colorado at Boulder or Black Canyon to create a reservoir to contain not less than 26,000,000 acre-feet. The measure provides also for the construction of the all-American canal, but Secretary Work has suggested an amendment providing that the canal is to be built only if Mexico is unwilling to modify the present concession, limiting the amount of water to which Mexican irrigators are to be entitled.

The $125,000,000 needed for the development is to be borrowed on the credit of the United States for repayment during a period not to exceed fifty years.

Representative Hayden, of Arizona, a member of the committee, is bitterly hostile to the measure, as it provides for the ratification of the Colorado River compact, when six of the seven states in the Colorado basin have approved it.

The bill requires the sale of power at the switchboard at such rates as will permit of the retirement of the bonds within the fifty year period. Under the strict requirements of the bill operation of the power plant need not be conducted necessarily by the government, as a proviso specifies that the Secretary of the Interior may enter into contracts for units of the plant "with right to generate electrical energy."

Obituary

William McKay, for the last fourteen years manager of the Toronto office of the Babcock-Wilcox & Goldie-McCulloch Co., died at his home 64 Marmaduke St., Toronto, Jan. 30. Mr. McKay was born 67 years ago in Seaforth, but had lived in Toronto since 1900. He had been ill for some time and several months ago was obliged to give up active service. He was widely known throughout the Dominion and had made for himself an enviable reputation in the power-plant field. Before entering the service of the Goldie-McCullock Co., many years before the merger of that company with the Babcock-Wilcox, Mr. McKay was with the Robb Engineering Works, Amherst, N. S. He is survived by his widow, two daughters and a son, George McKay, also in the Toronto office of the Babcock-Wilcox & Goldie-McCulloch Company.

Personal Mention

A. H. Parham has been appointed operating engineer of the Georgia Railway & Power Co., Atlanta, Ga.

Robert Geller has been transferred from Boston to the branch office of the B. F. Sturtevant Co. at Rochester, N. Y.

Farley Osgood, past-president of the N. E. L. A., has established a consulting engineering office in the National Bank of Commerce Bldg., New York City, to engage in the design, construction, operation and interconnection of public utilities.

Edith Clarke, an engineer of the G. E. Co. at Schenectady, N. Y., for the last six years, was the first woman member ever to address the A.I.E.E. She delivered a paper, "Calculations of Steady State Stability in Transmission Lines," at the midwinter convention which was held in New York City, recently.

C. H. Johnson, formerly traveling engineer in charge of power houses of the Central Indiana Power Co., and also with the operating department of Stone & Webster, Boston, has joined the Kennedy-Van Saun Manufacturing and Engineering Corp., manufacturers of ball and tube mills for pulverization and burning of coal, 50 Church St., New York City, as assistant to J. E. Kennedy, president of the company.

Gosta Anbro, formerly with the Eastman Kodak Co., has accepted a position as mechanical engineer with the Erie City Iron Works, Erie, Pa.

Society Affairs

The New York Section Meeting of the A.I.E.E. which was announced for Feb. 26 has been canceled. The subject of the meeting was to have been "Tidal Power Development at Passamaquoddy Bay."

The Hartford Engineers Club will hold a meeting on Feb. 24 at the Engineers Club, 12 Haynes St. A. A. Packard, of the Connecticut Power Co., will speak on "Accident Prevention—Electrical Forces," with special reference to electrical accidents in power stations.

The Electrical League of Elmira, N. Y., recently organized, is sponsoring an Electric Show which is to be held in that city March 6-13. Frank M. Houston, of the Elmira Water, Light & Railroad Co., is general chairman of the show, with H. S. Bryan acting as general manager.

The A.I.E.E. Great Lakes District will hold a regional meeting at Madison, Wis., May 6-7. Papers of interest to *Power* readers will be given: "Some Interconnected System Operating Problems," by Frank G. Boyce; papers on "Co-operation Between the Colleges and the Industries in Research," by William E. Wickenden, Dean A. A. Potter, Benjamin F. Bailey and Edward Bennett.

The Indianapolis Section of the A.S.M.E. will hold meetings at the Hotel Severin at 2:15 and 6:30 p.m. on Feb. 24, in connection with the 46th annual convention of the Indiana Engineering Society, Feb. 25-26. The afternoon subject will be "Measurement and Flow of Fluids," by James D. Cunningham, president, Republic Flow Meters Co., of Chicago; the evening session will have John L. Harrington address the dinner meeting on "The Engineer in Civic Life."

The Metropolitan Section of the A.S.M.E. will hold two meetings on Feb. 24 at the Engineering Building, 29 West 39th St., New York City. In the Auditorium at 8:15 Andrew A. Bato, Public Service Production Co., will speak on "Abbreviated Methods for Checking Flue-Gas Analysis"; H. B. Reynolds, Interborough Rapid Transit Co., J. M. Taggart, consulting engineer, and R. S. Lane, of the Interborough Rapid Transit Co., will speak on the "New Boiler Equipment at the Fifty-ninth Street power station of the Interborough. In Room 1 at the same hour, H. W. Brooks, consulting engineer, Fuller-Lehigh Co., will speak on "The Case of Low-Temperature Distillation in America."

Business Notes

The McClave-Brooks Co., Scranton, Pa., announces the appointment of T. B. Connors as sales manager for its Southeastern district territory, with headquarters at 1212 Atlanta National Bank Bldg., Atlanta, Ga.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Chemical Society. Charles L. Parsons, Mills Bldg., Washington, D. C. Convention at Tulsa, Okla. April 3-6.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at The Homestead, Hot Springs, Va., May 24-27.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **Ohio State Association,** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "P" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

The Celite Products Co., 1320 Hope St., Los Angeles, Calif., announces the removal of the San Francisco office from the Monadnock Bldg. to 140 Spear St.

The Reading Iron Co., Reading, Pa., announces that R. M. Thomas and Donald Charlton have been appointed technical representatives of the company. The technical department with which they are connected is a newly created service division of the sales department.

The Bearings Co. of America, Lancaster, Pa., announces that Frank M. Germans, formerly of the Gilliam Manufacturing Co. and the Timken Roller Bearing Co., will become the president of the new organization which is composed of a group of Philadelphia capitalists. The personnel of the organization will not be changed. Jack L. Straub will remain as vice-president in charge of operations.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Feb. 15 1926
Pool 1	New York	$2 90@$3 25
Smokeless	Boston	2.21
Clearfield	Boston	1 90@ 2.40
Somerset	Boston	2 00@ 2.60
Kanawha	Columbus	1 40@ 1 75
Hocking	Columbus	1 50@ 1 85
Pittsburgh	Pittsburgh	2 00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.15@ 1.25
Franklin, Ill.	Chicago	2 35@ 2 65
Central, Ill.	Chicago	2 00@ 2 25
Ind. 4th Vein	Chicago	2 25@ 2.35
West Ky.	Louisville	1 00@ 1.50
S. E. Ky.	Louisville	1 35@ 1 75
Big Seam	Birmingham	1.75@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1	New York	*None in Market*
Buckwheat No. 1	Philadelphia	
Birdseye	New York	

FUEL OIL

New York—Feb. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 9, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.00 per bbl.; 26@28 deg., $2.05 per bbl.; 28@30 deg., $2.10 per bbl.; 30@32 deg., $2.15 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Feb. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Feb. 13, f.o.b. local refinery; 26@30 deg., $1.65 per bbl.

Philadelphia—Feb. 12, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati—Feb. 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.55@$1.60.

New Plant Construction

Ark., Monette—Missouri Kansas Power Co., is in the market for raw water ice machinery to replace fire loss.

Calif., Modesto—Modesto Irrigation Dist., C. Abbott, Secy., plans to purchase drainage pumps. Estimated cost $7,600.

Calif., Riverside — Riverside Ice Co., plans the construction of addition to ice plant to increase the capacity from 20 to 40 tons daily.

Conn., Washington — Berkshire-Waramaug County Club, c/o J. Unger, 93 Amity St., Flushing, N. Y., plans the construction of a 2, 3 and 5 story club, including power plant, laundry, etc., at Waramaug Lake. Estimated cost $3,500,000.

Fla., Fort Lauderdale—C. E. Neville, A. D. Gray and Associates, Miami, are having plans prepared for the construction of a 6 story hotel at Thirteenth and First Sts. Estimated cost $600,000. W. A. Bennett, Miami, is architect.

Fla., Lakeland—Harneden Beach Hotel Corp., is having plans prepared for the construction of a 4 story hotel. Estimated cost $500,000. R. C. Snow, 93 Linwood Ave., Atlanta, Ga. is architect.

Fla., Pensacola—Emil Well, Inc., Whitney Bldg., New Orleans, Archts., will receive bids until March 1 for the construction of an 18 story annex to the "San Carlos" hotel here.

Fla., Tampa—City will soon award contract for the construction of a hospital. Estimated cost $1,000,000. M. L. Elliott, Citizens Bank Bldg., is architect.

Fla., Tampa — Tampa Electric Co., Tampa and Cass Sts., awarded contract for the installation of an additional 12,500 kw. unit and 4 boilers in existing turbine room at West Jackson Street station to Stone & Webster, 147 Milk St., Boston, Mass. Work includes extensions to boiler room, erection of 200 ft. stack, enlargement of outdoor substation by power house and installation of additional feeder to tie in the 11th Avenue substation. D. Gunn is construction superintendent.

Ill., Chicago — Michigan-Lake Building Corp., F. T. Hoyt, Pres., 160 North La Salle St., awarded contract for the construction of a 23 story office and stores building at Michigan Ave. and Lake St. to Paschen Bros., 111 West Washington St. Estimated cost $4,500,000.

Ind., Terre Haute—Bd. of Trustees of Indiana State Normal School, H. C. Benbridge, Secy., is receiving bids for General Electric, Westinghouse, American rotary valve and miscellaneous motors, 110 and 115 v., d.c., two generators, 45 and 125 kw., d.c., 1 electric hoist, 3 electric fans, 2 desk fans, etc.

Ia., Cedar Rapids — Waconia Sorghum Mills, Inc., Waconia, Minn., is receiving bids for the construction of a group of buildings for sorghum mills here. Machinery including motors, generators, boilers, tanks, vacuum evaporators, filters, pumps, etc., will be required.

Ky., Nortonville—The Kentucky Electric Power Corp., awarded contract for the design and construction of a 5,000-kw. steam electric power station, including high pressure boilers and turbines to The J. G. White Engineering Corp., 43 Exchange Place, New York, N. Y.

La., New Orleans—E. M. Loeb, Magazine St., A. F. Commagere, 910 Gravier St., New Orleans and S. S. Joy, 2001 West Pershing St., Chicago, Ill., awarded contract for the construction of an 18 story "Pere Marquette" office building at Baronne and Common Sts., here, to Ferro Construction Co., Third and Elm Sts. Cincinnati, Ohio. Estimated cost $1,500,000.

Mich., Detroit—Public Lighting Comn., 174 East Atwater St., awarded contract for the construction of boiler settings for new municipal power house on Morrell St. to Combustion Engineering Co., 51 Broad St., New York, N. Y. $239,500.

Minn., Rochester—Bd. of Education, S. L. Seamon, Clk., will soon award contract for the construction of a school and power plant including three 204 hp. boilers, stokers, pumps, ash conveyor system, oil burning equipment, etc. Estimated cost $300,000. H. H. Crawford, is architect.

Minn., Winona—Mississippi Valley Public Service Co., plans the construction of an additional unit to power plant including steam turbine, boilers, etc. Estimated cost $40,000. Engineer not selected.

Miss., Corinth—City awarded contract for the installation of a complete 1,000 kw. unit in power plant to Westinghouse Electric & Mfg. Co., Chamber of Commerce Bldg., Pittsburgh, Pa., $28,300.

Miss., Laurel—J. L. Summer, Newton, plans the construction of a 25-ton ice manufacturing plant here.

Miss., Winona—J. Q. Staples, Mayor and Bd. of Alderman, will receive bids until March 2 for furnishing and installing one 1,000 gal. combination electric motor and gasoline engine driven fire pump complete with all auxiliary equipment, one 750 gal. motor driven fire pump, one 375 gal. motor driven service pump, etc. H. E. Johnson, is city superintendent.

Mo., Marionville—Marionville Cold Storage Co., awarded contract for the construction of a 4 story cold storage and refrigeration plant to Easley Bros., Aurora. $50,000.

Nev., Reno—University of Nevada, plans the construction of a central heating plant. Estimated cost $40,000.

N. J., Newark—Bd. of Freeholders, Essex Co., E. C. Ball, Chn. of Building Committee, Court House, will receive bids about March 3 for the construction of a hall of records and power house on High St. Estimated cost $2,100,000. Guilbert & Betelle, Chamber of Commerce Bldg., are architects. Runyon & Carey, Broad St., are engineers.

N. J., Newark—Keystone Varnish Co., 71 Otsego St., Brooklyn, N. Y., will soon award contract for the construction of a factory including boiler plant, sprinkler system, tanks, elevators, etc., here. Estimated cost $300,000. Fletcher-Thompson Co., 350 Madison Ave., New York, N. Y., is architect and engineer.

N. Y., Buffalo—W. J. Conners, 250 Main St., plans the construction of an office building on Niagara Square. Estimated cost $1,000,000.

N. Y., New York—Consolidated Gas Co., 130 East 15th St., is having plans prepared for the construction of a boiler house on Hunts Point Ave. Estimated cost $175,000. J. F. Hunter, 30 East 58th St., is engineer.

N. Y., New York—Herogal Construction Co., c/o G. & E. Blum, 505 5th Ave., Archts., plans the construction of a 16 story office building at 316 West 36th St. Estimated cost $1,000,000. Work will be done by separate contracts under the supervision of the architects.

N. D., Hettinger—Hettinger Bridge Co., is in the market for pumps to be used in pumping water from bridge footing excavations.

O., Akron—City, P. Gott, Secy., is having plans prepared for the construction of a laundry and heating plant on East Market St. Estimated cost $100,000. Good & Wagner, Buckeye Bldg., are architects. A 200 hp. boiler, automatic stokers, coal and ash handling equipment, etc., will be required.

O., Columbus—Bd. of Purchases, H. C. Cain, Secy., City Hall, is in the market for two 1667 kva., 60 cycle, single ph., 2,300 to 6,900 v. oil immersed water cooled power transformers ,for municipal light plant.

Okla., Talhlequah—C. Page, Chamber of Commerce Bldg., Sand Springs, has been granted permit by the State Commission to construct a hydro-electric plant and dam, 700 ft. long x 60 ft. high across the Illinois River to furnish power for several cities near here. Estimated cost $690,000. C. Tingley, Sand Springs, is engineer.

Pa., Philadelphia—Dept. of Public Works, Bureau of Engineering, will receive bids until Feb. 24 for Schedule "C" South Philadelphia Improvement; sewers and pumping station, south of Packer and west of Broad Sts., sewers and pumping equipment, south of Pattison Ave. and west of Broad St.

Pa., Phoenixville—Philadelphia Suburban Water Co., Fox Bldg., Philadelphia, plans the construction of a 68 x 154 ft. filter and pumping station, also dam 1,500 ft. long x 40 ft. high, here. Private plans. Contract for pumping and filter equipment has been awarded.

Tenn., McMinnville—City will receive bids until March 4 for the construction of a pumping station, filtration plant, 3 units, each 500,000 g.p.d., 250,000 gal. reservoir, 6 centrifugal pumps and electric motors, 100,000 gal. tank on tower, etc. Klyce & Harrub, Fourth and First National Bank Bldg., Nashville, are engineers, J. T. Johnson, is mayor.

Tenn., Tullahoma — Campbell & Dann Mfg. Co., is in the market for a 125 to 175 hp. Corliss engine.

Tex., San Marcos—Texas Public Utilities Co., subsidiary of the Texas Power & Light Co., River Bank and Franklin Ave., Waco, plans to rebuild ice plant, 45 ton daily capacity here. Estimated cost $50,000. Work will be done by day labor. Owner will purchase equipment, to be electrically driven.

Tex., Waco—City, T. P. Stone, Mayor, will receive bids until March 2 for the construction of a sewage treatment plant, including main pumping station, East Waco pumping station, 3 compressors, two 1,500 and one 2,500 free air per minute capacity, two 4 in. and one 6 in. vertical centrifugal sewage pumps with motors and switches, two 4 in. single diaphragm type sludge pumps. Terrell Bartlett, Inc., Engrs., 614 Calcasieu Bldg., San Antonio, are engineers. V. G. Koch, is city engineer.

Tex., West—City has acquired the West Water Co.'s plant and will have surveys made for improvements to same including new pumping machinery, etc.

Wash., Seattle—The City Light Dept. has filed application with R. K. Tiffany, supervisor of hydraulics, for reservoir permit and water rights for an $11,000,000 expansion of the Skagit River hydro-electric power project. A dam, 800 ft. long and 350 ft. high will span Diablo Canyon through which the Skagit River flows and the reservoir will impound 90,000 acre feet and submerge 700 acres, 100 to 320 feet deep. Estimated cost $3,000,000.

W. Va., Kenova — The Consolidated Power & Light Co., W. R. Power, Gen. Mgr., subsidiary of the American Electric Power Co., Witherspoon Bldg., Philadelphia, Pa., has authorized the expenditure of $1,500,000 for improvements to plant to double the capacity here. Work will be done under the direction of A. J. Kuylernstjerna, Ch. Engr. of the American Electric Power Co. Contracts for the installation of a 30,000 kva. turbine, several 1,400 hp. boilers and other equipment have been awarded.

Wis., Baraboo—City, S. H. Wood, Clk., will receive bids until March 2 for one 450 g.p.m. single acting triplex plunger pump against a 260 ft. head. H. E. French, City Hall, is engineer.

Wis., Milwaukee—E. Brielmaier & Sons, 432 Broadway, Archts., are preparing preliminary plans for the construction of a 4 story convent including power house, laundry, etc. Owner's name withheld.

Wis., Milwaukee — Red Star Yeast & Products Co., 79 Buffalo St., is having plans prepared for the construction of a dry house. Estimated cost $75,000. E. R. Siebert, 49 Oneida St., is architect. Refrigeration machinery for remodeling of cold storage building, conveyors, etc., will be required.

Wis., Wauwatosa — Milwaukee County, W. L. Coffey, Mgr. of Institutions, plans the construction of an addition to central power plant. Estimated cost $316,000. Architect and engineer not selected.

Wis., West Allis—Woodlawn Farm Dairy, is having plans prepared for the construction of a dairy plant on 77th Ave. Estimated cost $40,000. F. Pfeifer, 586 66th Ave., is architect. Refrigeration and dairy machinery will be required.

Ont., Ford City—Town, J. F. Foster, Clk., plans the installation of an auxiliary electric power plant in connection with filtration plant. Estimated cost $10,000.

Ont., Kapuskasing—Spruce Falls Pulp & Paper Co., is having plans prepared for the construction of a newsprint mill, 400 to 500 ton daily capacity, here, also a hydro-electric power plant on the Mattagami River at Smoky Falls. Estimated cost $10,000,000. G. F. Hardy, 305 Broadway, New York, N. Y., is engineer.